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NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

THESIS

METHODS FOR DETERMINING GOALS AND EXPECTATIONS FOR FIELDED JET ENGINES

by

John A. Malsbury

December, 1995

Thesis Advisor: W. Max Woods

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This thesis investigates methods for determining goals and expectations for fielded jet engines. Some of these methods employ concepts used in Reliability Centered Maintenance (RCM). The procedures developed here can be applied to any fielded jet engine. The data used by this thesis was extracted from the Naval Aviation Logistics Data Analysis (NALDA) database. The desktop software programs that were used to attain reliability parameters are readily available to any command. The data analysis accomplished here demonstrated that cannibalization of engines has impacted adversely on reliability. A model was developed to determine no-build times for jet engines at the Intermediate Maintenance and Depot level of repair based on engine reliability and the conditional probabilities of survival of significant components of the engine and their specified maximum operating times.

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METHODS FOR DETERMINING GOALS AND EXPECTATIONS FOR FIELDED JET ENGINES

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ABSTRACT

This thesis investigates methods for determining goals and expectations for fielded jet engines. Some of these methods employ concepts used in Reliability Centered Maintenance (RCM). The procedures developed here can be applied to any fielded jet engine. The data used by this thesis was extracted from the Naval Aviation Logistics Data Analysis (NALDA) database. The desktop software programs that were used to attain reliability parameters are readily available to any command. The data analysis accomplished here demonstrated that cannibalization of engines has impacted adversely on reliability. A model was developed to determine no-build times for jet engines at the Intermediate Maintenance and Depot level of repair based on engine reliability and the conditional probabilities of survival of significant components of the engine and their specified maximum operating times.

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LIST OF ABBREVIATIONS

θ	Theta - Weibull Distribution Scale Parameter
β	Beta - Weibull Distribution Shape Parameter
A/C	Aircraft
ASO	Aviation Supply Office
CDF	Cumulative Distribution Function
CIP	Component Improvement Program
CR	Cannibalization
DMC	Defense Megacenter
ERAP	Engine Reliability Analysis Program
FHSN	Flight Hour Since New
FHSR	Flight Hour Since Repair
HEMP	Hourly Engine Maintenance Program
HPT	High Pressure Turbine
HSI	Hot Section Inspection
HT	Hard Time
IMA	Intermediate Maintenance Activity
LPT	Low Pressure Turbine
MEI	Major Engine Inspection
MIM	Maintenance Instruction Manual
MTBF	Mean Time Between Failure
NADEP	Naval Aviation Depot
NALDA	Naval Aviation Logistics Data Analysis
NAWCADPPE	Naval Air Warfare Center Aircraft Division and Power Engineering
P/REASON	Previous Reason for Removal

LIST OF ABBREVIATIONS

PDF	Probability Density Function
RAP	Reliability Analysis Program
RCM	Reliability Centered Maintenance
REA-REM	Reason for Removal
REM-UIC	Removal Unit Identification Code
SERNO	Serial Number
SI	Significant Item
SSC	Status Star Code
STD DEV	Standard Deviation

I. INTRODUCTION

A. BACKGROUND

1. Reliability Analysis Program

For the past decade, the Component Improvement Program (CIP) has been an important element in aircraft logistical support of aircraft engines. In the face of declining Navy budgets, it is vital to improve maintenance programs for aircraft engines and make full use of engine failure data in the process. A primary purpose of this thesis is to develop analytical tools that can be used to conduct analysis of segments of the TF34 engine data base to enhance maintenance and logistics decision making.

A first step in this effort approach was the Reliability Analysis Program (RAP). [Ref. 1: p. 4]

> The program seeks to reduce the risks of catastrophic failures and loss of engine and/or airframe. This requires better estimates of engine and hence component's reliability. While that program is mainly focused on developing a better Reliability Centered Maintenance (RCM) program, it will also provide a baseline from which to seek improvements in the "ilities." [Ref. 1: p. 4]

This thesis focuses on supporting the Engine Reliability Analysis Program (ERAP) in conjunction with the RCM program. The engine selected for analysis is the TF34 Turbofan jet engine which powers the S-3 aircraft.

2. Engine Reliability Analysis Program (ERAP)

The Naval Air Warfare Center Aircraft Division and Power Engineering (NAWCADPPE) was tasked with analyzing and reporting factors that influence engine reliability. The database used in the ERAP program is the Naval Aviation Logistics Data

Analysis (NALDA) database. The ERAP information is ultimately used by engine management teams to develop sound management policy designed to enhance engine reliability. [Ref. 2: p. 1]

3. Naval Aviation Logistics Data Analysis (NALDA)

NALDA is an operational Automated Information System that is a centralized Aviation 3M data bank used on an interactive basis with logisticians, engineers, analysts, and staff. Secondary sources to NALDA are the Naval Aviation Depots (NADEP) and the Aviation Supply Office (ASO). The computer services are provided by the Defense Megacenter (DMC) Mechanicsburg, PA. [Ref. 3]

B. RESEARCH QUESTIONS

The specific ERAP information, such as engine reason for removal and Flight Hours Since Repair (FHSR), of the five year data base can be used to address the following questions:

1. Has cannibalization had less adverse impact on TF34 engine reliability in recent years?

2. Does the reliability of TF34 engines decrease as the number of repairs increase?

3. How can cost effective no-build times be chosen for significant engine components that have designated hard inspection/repair times?

C. METHODOLOGY OF DATA ANALYSIS

The five-year database was divided into one-year segments as indicated below and the following analysis conducted:

1. Construct engine failure data sets that will be used to assess the effect of cannibalization subsequent time to failure. This analysis is performed on the five year data base as a whole, on individual fiscal years, and on the most recent two fiscal years combined.

2. For each fiscal year and the most recent two fiscal years of the TF34 data base, remove small engine failure times on an incremental basis to develop different categories of data sets that will be analyzed.

The categories are defined as follows:

- **All** (all failure times)
- **Less Zero** (delete failure times that have zero FHSR)
- **Less 10%** (delete the first 10% of the failure times starting with the lowest FHSR records first)
- **Less 50% < 100 FHSR** (delete 50% of the failure times that are less than 100 FHSR)
- **Less 80% < 100 FHSR** (delete 80% of the failure times that are less than 100 FHSR)

For each data set, the Mean Time Between Failure (MTBF) was calculated using two different procedures. One procedure uses a parametric approach that fits a Weibull distribution to the population of failure times in the data set. The second procedure computes the MTBF non-parametrically. A more detailed description of these two procedures is provided in Chapter II.

3. Plot the number of cannibalization removals each year.

4. For each data set, compute and analyze reliability values and conditional reliability values.

5. Develop models for computing cost effective no-build times for Significant Items that have been assigned maximum operating times. These items have a no-build time limit used to determine when a replacement component will be installed into an engine that is undergoing repair even though the maximum operating time has not been accumulated on the Significant Item. These models employ conditional survival probabilities of Significant Items and reliabilities of the TF34 engines.

D. SCOPE, LIMITATIONS, AND ASSUMPTIONS

The scope of this research is focused on the TF34 engine. Particular attention was taken with respect to the fiscal year when an engine was removed. This resulted in deleting some record entries that fall outside the fiscal years 1990 to 1994. For example, engines having been removed September 1994 is a relevant data record. However, an engine removed October 1994 would be deleted because the removal occurred in fiscal 1995. The author of this thesis assumes that readers posses knowledge of statistical analysis and spreadsheet software functions, logic, and procedures. The spreadsheet software program utilized with this thesis is Microsoft Excel version 5.0.

II. THE AFFECTS OF LOW FAILURE TIMES AND CANNIBALIZATION ON TF34 ENGINE MTBF

A. PROCEDURES FOR DATA ANALYSIS AND STATISTICAL CALCULATIONS

The analysis of the influence that low failure times and engine cannibalization actions have on MTBF was done from a NALDA database sort for fiscal years 1990 to 1994 for the TF34 engine. The data was in the form of ERAP reports, Removal/Downgrades and Flight Hours Between Repairs. The data was converted to an Excel spreadsheet and established a working data base of 1812 engine records. [Ref. 2] This data is presented in detailed form in Appendix A. A statistical data comparison was performed for each fiscal year. Failure times that had non-failure engine removal reasons were deleted from the data set which left a data set with only actual engine failure times. Specifically, these removal codes were 3E (faulty handling), 4B (accidental/incidental damage), 4D (directed removal by Type Commander), 4L (damaged in transit), 5G (overhaul-hightime), 6A (modification-technical directive incorporation), 7C (high-time component only), 7D (high-time COMP/HEMP/HSI), and 3W (cannibalization). The engine population presented in Table 1 represents engine failure conditions (turbine failure, engine seizure, compressor blades cracked, etc.) previously defined in Caudill's thesis [Ref. 2] less 26 records for no flight hour entry and engine removals occurring in fiscal year 1995 resulting in 697 total engine records. The mathematical formulas used to compute MTBF are applicable to any engine failure condition. That is, any reason for removal can isolate an engine population to which the formulas and spreadsheet procedures illustrated in Appendix B can be applied. It is important to note that because the removal

codes cited above have been removed from the original data set, the remaining time between removals are actually time between engine failures. Therefore, Mean Time Between Removal, MTBR is really MTBF, Mean Time Between Failure.

B. THE CONVENTION FOR DELETING ENGINE RECORDS

The convention on how engine records were deleted to develop the different data categories are listed below. The values of beta and theta of the fitted Weibull distribution and the MTBF and STD DEV of the population of failure times is given in Table 1.

Weibull	**All**: Consists of all the failure data in the data set using the Weibull formulas.
Nonpara	**All**: Consists of all the failure data in the data set using the Non-Parametric formulas.
Weibull	**Less zero:** The failure times in this category that had a zero entry in the Flight Hour Since Repair (FHSR) cell and was deleted from the data set.
Non-Par	**Less zero:** The same set of data that was used to compute Weibull - less zero is used here. However, the Non-Parametric equations are used to calculate MTBF and the standard deviation.
Weibull	**Less 10%**: N = Engine Population. N - (.10*N). The convention is to delete the failure times in ascending order starting at zero and ending at (.10*N). This would delete the lowest FHSR times first.
Nonpara	**Less 10%:** The same set of data that was used to compute Weibull - less 10% is used here. However, the Non-Parametric equations are used to calculate MTBF and the standard deviation.
Weibull	**Less 50% < 100**: 50% of FHSR, less that a 100 hours, are deleted from the data set. The lowest failure times are deleted first.
Nonpara	**Less 50% < 100**: The same set of data that was used to compute Weibull - less 50% < 100. However, the Non-Parametric formulas are used to calculate MTBF and the standard deviation.
Weibull	**Less 80% < 100**: 80% of FHSR, less that a 100 hours, are deleted from the data set. The lowest failure times are deleted first.
Nonpara	**Less 80% < 100**: The same set of data that was used to compute Weibull - less 80% < 100. However, the Non-Parametric formulas are used to calculate MTBF and the standard deviation.

FY90-FY94	# of records	BETA	THETA	MTBF	STD DEV
Weibull - All	697	1.2032	515.36	484.28	403.75
Nonpara - All	697			477.65	420.88
Weibull - less zero	659	1.3009	555.68	513.32	398.57
Nonpara - less zero	659			505.19	416.46
Weibull - less 10%	627	1.3884	590.08	538.50	392.64
Nonpara - less 10%	627			530.79	410.84
Weibull - less 50% < 100	613	1.4821	605.00	549.93	390.61
Nonpara - less 50% < 100	613			542.59	407.93
Weibull - less 80% < 100	563	1.5771	659.56	591.79	385.23
Nonpara - less 80% < 100	563			587.11	396.04

FY90	# of records	BETA	THETA	MTBF	STD DEV
Weibull - All	172	0.9705	405.28	398.61	398.61
Nonpara - All	172			411.34	420.77
Weibull - less zero	161	1.0554	449.86	440.81	415.03
Nonpara - less zero	161			439.44	420.47
Weibull - less 10%	155	1.1039	474.83	458.32	413.68
Nonpara - less 10%	155			456.34	419.48
Weibull - less 50% < 100	146	1.1784	512.82	484.92	413.61
Nonpara - less 50% < 100	146			483.54	417.20
Weibull - less 80% < 100	130	1.3198	583.04	537.20	412.02
Nonpara - less 80% < 100	130			538.00	410.33

FY91	# of records	BETA	THETA	MTBF	STD DEV
Weibull - All	148	1.2557	556.59	518.40	413.22
Nonpara - All	148			506.64	441.11
Weibull - less zero	139	1.3834	605.89	552.92	407.07
Nonpara - less zero	139			539.44	435.25
Weibull - less 10%	133	1.4746	638.84	578.15	399.78
Nonpara - less 10%	133			563.66	429.37
Weibull - less 50% < 100	129	1.5061	649.81	585.91	398.02
Nonpara - less 50% < 100	129			580.89	424.47
Weibull - less 80% < 100	118	1.7264	721.46	643.13	384.44
Nonpara - less 80% < 100	118			632.15	407.44

Table 1. TF34 Database Statistical Analysis

FY92	# of records	BETA	THETA	MTBF	STD DEV
Weibull - All	157	1.3068	551.34	509.31	391.67
Nonpara - All	157			500.90	411.68
Weibull - less zero	152	1.3644	573.63	524.68	391.28
Nonpara - less zero	152			517.37	408.05
Weibull - less 10%	141	1.4975	622.83	562.60	383.75
Nonpara - less 10%	141			555.98	398.52
Weibull - less 50% < 100	142	1.4852	618.38	558.59	384.74
Nonpara - less 50% < 100	142			552.43	399.35
Weibull - less 80% < 100	133	1.6002	658.76	590.20	378.62
Nonpara - less 80% < 100	133			585.48	391.13

FY93	# of records	BETA	THETA	MTBF	STD DEV
Weibull - All	120	1.3402	537.01	493.55	370.26
Nonpara - All	120			483.53	393.60
Weibull - less zero	117	1.3877	553.88	505.46	368.55
Nonpara - less zero	117			495.92	390.85
Weibull - less 10%	108	1.5397	604.94	544.52	361.19
Nonpara - less 10%	108			536.85	378.99
Weibull - less 50% < 100	108	1.5397	604.94	544.52	361.19
Nonpara - less 50% < 100	108			536.85	378.99
Weibull - less 80% < 100	102	1.6489	639.2	571.88	354.4
Nonpara - less 80% < 100	102			566.40	369.16

FY94	# of records	BETA	THETA	MTBF	STD DEV
Weibull - All	99	1.2900	553.3	512.48	398.93
Nonpara - All	99			498.91	429.62
Weibull - less zero	89	1.5285	634.62	571.23	382.64
Nonpara - less zero	89			554.97	417.23
Weibull - less 10%	89	1.5285	634.62	571.23	382.64
Nonpara - less 10%	89			554.97	417.23
Weibull - less 50% < 100	87	1.5815	650.97	584.97	376.5
Nonpara - less 50% < 100	87			567.64	413.39
Weibull - less 80% < 100	80	1.7834	708.39	633.78	358.68
Nonpara - less 80% < 100	80			615.45	396.56

FY93-94	# of records	BETA	THETA	MTBF	STD DEV
Weibull - All	219	1.3208	545.23	502.36	381.6
Nonpara - All	219			490.48	409.41
Weibull - less zero	206	1.4447	588.58	533.71	374.07
Nonpara - less zero	206			521.43	402.53
Weibull - less 10%	197	1.5372	618.82	557.01	369.48
Nonpara - less 10%	197			545.13	395.66
Weibull - less 50% < 100	195	1.5585	625.57	562.16	367.63
Nonpara - less 50% < 100	195			550.64	393.90
Weibull - less 80% < 100	181	1.7163	672.93	599.86	362.8
Nonpara - less 80% < 100	181			590.91	380.13

Table 1. TF34 Database Statistical Analysis

C. NON-PARAMETRIC AND WEIBULL METHODS AND ANALYSIS

The Weibull and Non-Parametric formulas and spreadsheet procedures are explained in Appendix B.

1. Non-Parametric Approach

> It is often the case in practical applications that a specific distribution assumption is not tenable. In these circumstances, it is desirable to base inferences on tests that are valid over a wide range of distributions of the parent population. Such tests are called Non-Parametric, or distribution free. [Ref. 4: p. 413]

In this approach, all inferences are drawn from the working data base using Non-Parametric statistics. Consequently, inferences about performance measures are not susceptible to criticism relevant to an assumed probability distribution. [Ref. 2: p. 4] The approach to establish a Non-Parametric probability distribution was to arrange the time between repairs in ascending order for the respective fiscal years for the time between repair and apply equation (6), of Appendix B, along with the corresponding spreadsheet procedure. This approach was used to compute MTBF of the TF34 engine for each of the individual fiscal years and their different categories. The results of these calculations are presented in Table 1.

2. Weibull Approach

The Non-Parametric method of analysis is not as useful as parametric analysis for some types of advanced analysis. Therefore, a parametric analysis was performed to provide a fit of a Weibull distribution to the data. The Weibull distribution can be used to model the distribution of failure times for an item that has a wear-in, wear-out, or neither. The mathematical equations (1) - (5) that describe the method for fitting a Weibull distribution to the population of failure times for each data set along with their

corresponding spreadsheet procedures are given in Appendix B. Additionally, Appendix B describes how estimates of the two parameters θ (theta) and β (beta) for the Weibull distribution were obtained. The results of the Weibull distribution parameter computations are provided in Table 1.

D. THE WEIBULL DISTRIBUTION

The fitted Probability Density Function (PDF) of a continuous random variable, T, can be used to compute all probabilities about the random variable. In particular, the reliability function, R(t), is the area under the density function beyond t. Nearly all density functions have parameters. The Weibull distribution is characterized by two parameters, θ and β. The reliability function for the Weibull distribution is $R(t) = e^{-(t/\theta)^{\beta}}$. The parameter β is the shape parameter. If $\beta = 1$, then the Weibull distribution is an Exponential distribution. For $\beta = 3.25$ or larger, the Weibull distribution approximates a Normal density function. [Ref. 5: p. 69] A graphical illustration of this is in Figure 1. For the data set FY90 All in Table 1, $\beta = .9705$. When the shape parameter is less than one, the curve will be an extremely steep declining curve and has the y-axis as an asymptote at $t = 0$. Manufacturers consider this case to be an indication of parts failing during a wear-in period. [Ref. 5: p. 69] Relating this to the TF34 this could indicate parts failing shortly after repair or correcting faults made during repair. For the FY94 less 50% data set in Table 1, $\beta = 1.5815$ and $\theta = 650.97$. Figure 1, displays Weibull PDF for these two parameter values. Additionally, Figure 1 shows that the Weibull PDF for $\beta = 3.25$ approximates a Normal density function. The spreadsheet procedures used to produce Figure 1 are described in Appendix B.

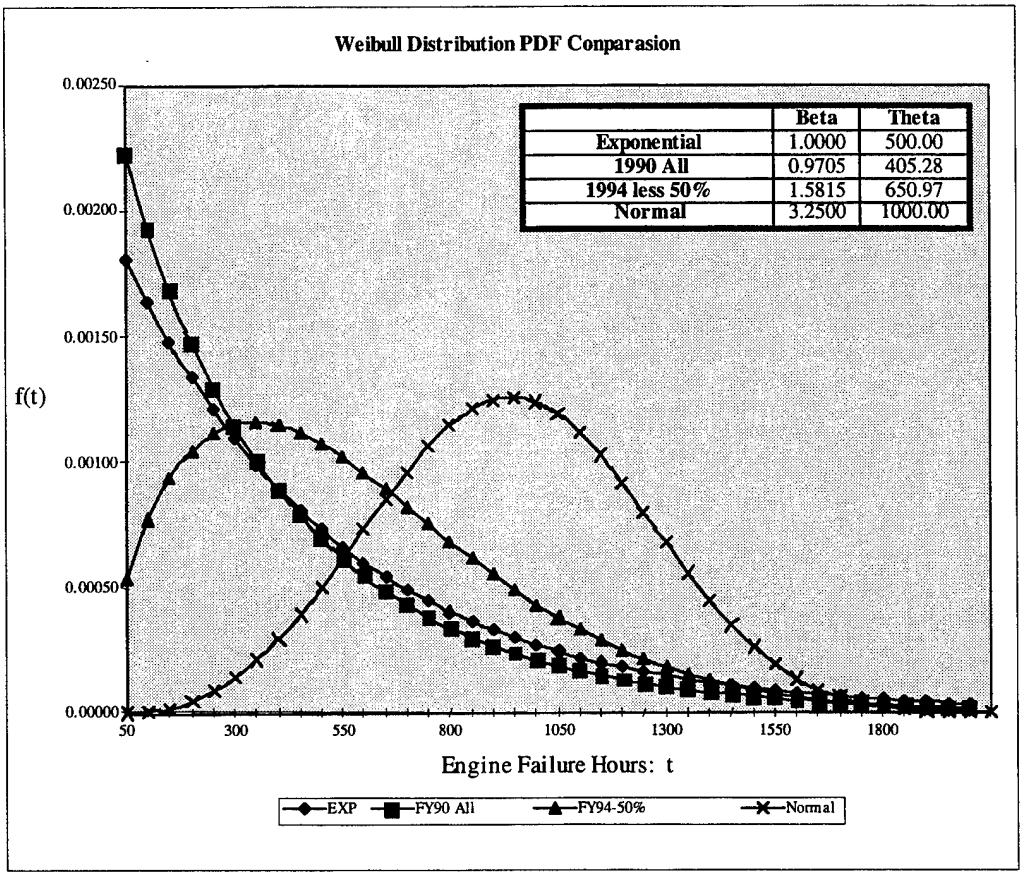


Figure 1. Weibull PDF

E. IMPACT OF LOW FAILURE TIMES ON MTBF

Certain goals could be targeted to increase MTBF with respect to low failure times on the TF34 engine. For example, the MTBF for the FY 93-94 All data set in Table 1, is 502 flight hours. This number is a consequence of the current maintenance policy. Incremental reductions (deletions) in low failure times were made for this same data set and the resulting MTBFs computed. The incremental increases in MTBF are shown in Figure 2. These increases in MTBF are significant. The reason the data is so sensitive to low failure time removal is because they represent such a large

FY93-94	Theta	Beta	MTBF Base	MTBF Increment	% Increase
Weibull All	545.23	1.3208	502.4	0.0	0%
Weibull Less Zero	588.58	1.4447	533.7	31.3	6%
Weibull - Less 10%	618.82	1.5372	557.0	54.6	11%
Weibull - Less 50% <100	625.57	1.5585	562.2	59.8	12%
Weibull - Less 80% <100	672.93	1.7163	599.9	97.5	19%

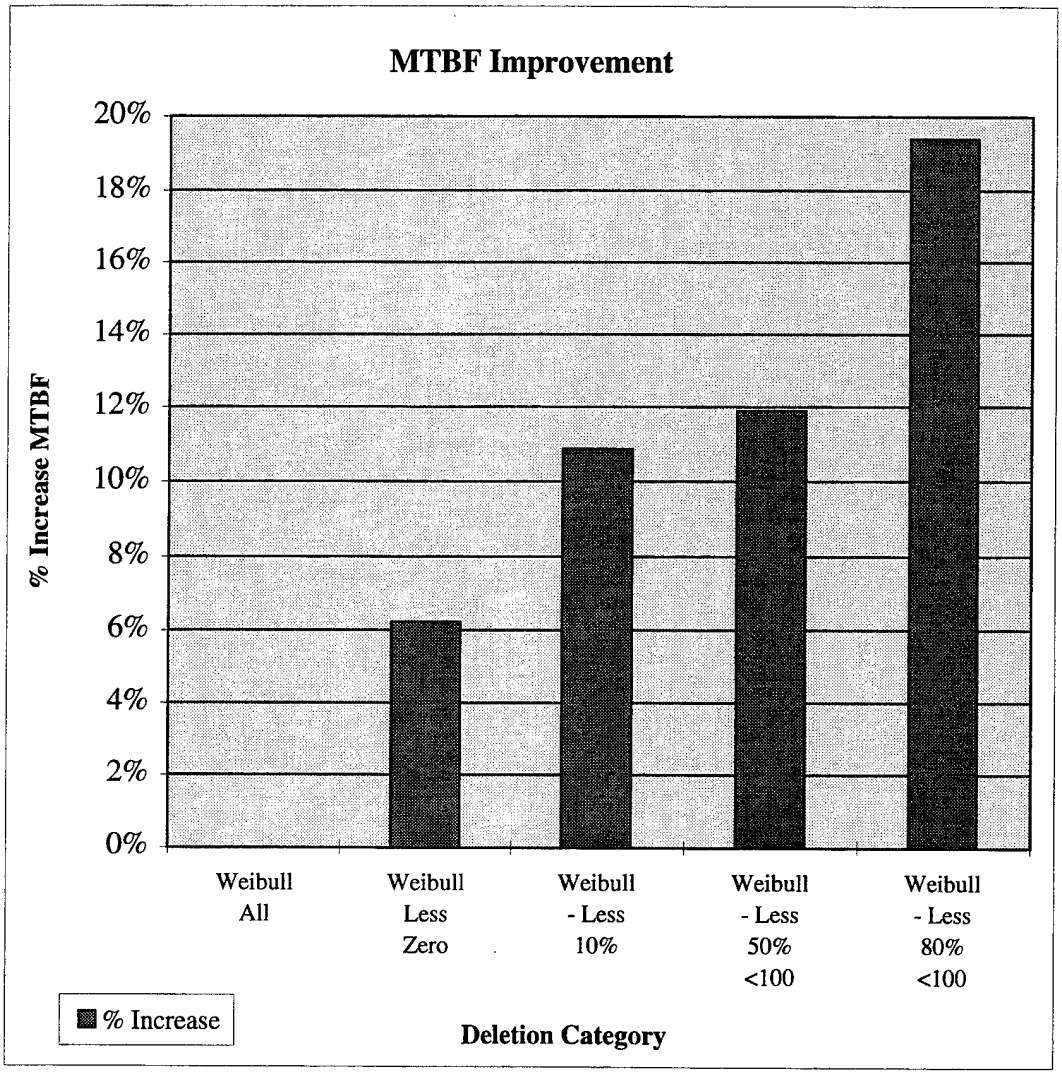


Figure 2. MTBF Improvements with Low Failure Time Reductions

portion of the five year TF34 database. Therefore, if an engine manager could implement changes in maintenance policies that significantly reduces engine low failure times he could increase MTBF and reliability significantly. For example, if he were successful in removing 80% of the low failure times less than 100 FHSR, he would effect an increase in MTBF from 502 hours to 600 hours (a 19% increase). The values for theta and beta were previously computed for fiscal years 93-94 and were presented in Table 1. Section D of this chapter presented the reliability function for the Weibull distribution is $R(t) = e^{-(t/\theta)^{\beta}}$. Therefore, the corresponding change in reliability at 300 hours, R(300), would increase from .6349 to .7788 (a 14% increase). These reliability values are computed using a spreadsheet with the Weibull distribution reliability function programmed into it. The reliability results are presented in Table 2. The left two columns pertain to the 1993-94 Weibull-All data set. The right two columns pertain to the 1993-94 Weibull-Less 80% < 100 data set.

FY93-94 Weibull All Data Set	
Theta	545.23
Beta	1.3208
t	R(t)
50	0.9583
100	0.8990
150	0.8337
200	0.7665
250	0.6997
300	0.6349
350	0.5730
400	0.5147
450	0.4602
500	0.4099
550	0.3636
600	0.3215
650	0.2833
700	0.2488
750	0.2179
800	0.1903
850	0.1657
900	0.1439
950	0.1247
1000	0.1077
1050	0.0929
1100	0.0799
1150	0.0686
1200	0.0587
1250	0.0502
1300	0.0428
1350	0.0364
1400	0.0310
1450	0.0263
1500	0.0222
1550	0.0188
1600	0.0158
1650	0.0133
1700	0.0112
1750	0.0094
1800	0.0079
1850	0.0066
1900	0.0055
1950	0.0046
2000	0.0038

FY93-94 Weibull Less 80% < 100	
Theta	672.93
Beta	1.7163
t	R(t)
50	0.9885
100	0.9628
150	0.9268
200	0.8828
250	0.8329
300	0.7788
350	0.7221
400	0.6640
450	0.6058
500	0.5485
550	0.4929
600	0.4399
650	0.3898
700	0.3430
750	0.2998
800	0.2604
850	0.2247
900	0.1926
950	0.1641
1000	0.1390
1050	0.1170
1100	0.0978
1150	0.0814
1200	0.0673
1250	0.0553
1300	0.0452
1350	0.0368
1400	0.0297
1450	0.0239
1500	0.0191
1550	0.0152
1600	0.0120
1650	0.0095
1700	0.0074
1750	0.0058
1800	0.0045
1850	0.0034
1900	0.0026
1950	0.0020
2000	0.0015

Table 2. Weibull Reliability Calculations

F. ANALYSIS OF CANNIBALIZATIONS ON MTBF

1. Annual Cannibalizations

In this section a summary is given for the number of engines that were cannibalized (CR) on an annual basis. This can be seen graphically in Figure 3.

Annual Totals FY90-94

Fiscal Year	Annual CR
1990	181
1991	142
1992	131
1993	42
1994	67

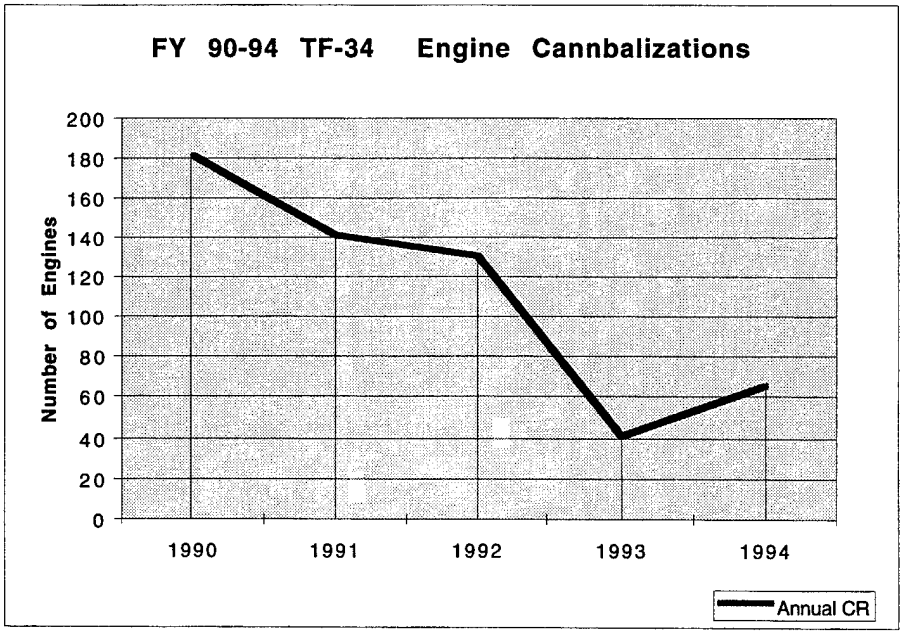


Figure 3. Annual Cannibalizations

2. Cannibalization Impact on MTBF

Isolating an engine population for a specific failure condition is one of the methodologies used in this thesis. The author has chosen the impact of engine cannibalization reason for engine removal (3W), because these actions represent a large portion of the non-failure time data of the entire TF34 database. The five year database represented by 1812 engine records. Of these records, 563 represent cannibalization engine removals for FY 90-94. The population with the next largest non-failure times are for engines removed for high-time components which will be discussed in detail in Chapter IV.

a. Procedure for Establishing Cannibalization Impact on MTBF

Caudill's thesis [Ref. 2] produced a database to analyze the impact of cannibalization actions on MTBF of the TF34 engine. For each cannibalization that was followed by a failure he computed the number of flight hours before that failure occurred. He made these computations for the entire five year database. This established a database of cannibalization engine failures. Caudill's thesis established that cannibalization actions have an adverse impact on the TF34 engine MTBF with respect to the entire five year database. To analyze whether cannibalization actions have had less adverse impact on engine failure times in the most recent years, the five year database was divided into the five individual fiscal years and statistical analyses were conducted on each year to determine the mean, standard deviation, and the median of these failure times. The results are presented in Table 3. A graphical representation of these results are presented in Figure 4.

Statistic FY90	Cannibalization Followed By Engine Failure	Failure Data Comparison Table 1, All Category
# of Engines	33	
Max (Flt Hrs)	830	
Min (Flt Hrs)	0	
MTBF(FLt Hrs)	**116**	**399**
Std Dev (Flt Hrs)	190	399
Median (FLt Hrs)	32	

Statistic FY91	Cannibalization Followed By Engine Failure	Failure Data Comparison Table 1, All Category
# of Engines	36	
Max (Flt Hrs)	1018	
Min (Flt Hrs)	0	
MTBF(FLt Hrs)	**251**	**518**
Std Dev (Flt Hrs)	222	413
Median (FLt Hrs)	253	

Statistic FY92	Cannibalization Followed By Engine Failure	Failure Data Comparison Table 1, All Category
# of Engines	42	
Max (Flt Hrs)	1140	
Min (Flt Hrs)	0	
MTBF(FLt Hrs)	**304**	**509**
Std Dev (Flt Hrs)	302	392
Median (FLt Hrs)	252	

Statistic FY93	Cannibalization Followed By Engine Failure	Failure Data Comparison Table 1, All Category
# of Engines	45	
Max (Flt Hrs)	1099	
Min (Flt Hrs)	0	
MTBF(FLt Hrs)	**302**	**494**
Std Dev (Flt Hrs)	311	370
Median (FLt Hrs)	187	

Statistic FY94	Cannibalization Followed By Engine Failure	Failure Data Comparison Table 1, All Category
# of Engines	17	
Max (Flt Hrs)	986	
Min (Flt Hrs)	0	
MTBF(FLt Hrs)	**215**	**512**
Std Dev (Flt Hrs)	302	399
Median (FLt Hrs)	120	

Table 3. Cannibalization MTBF

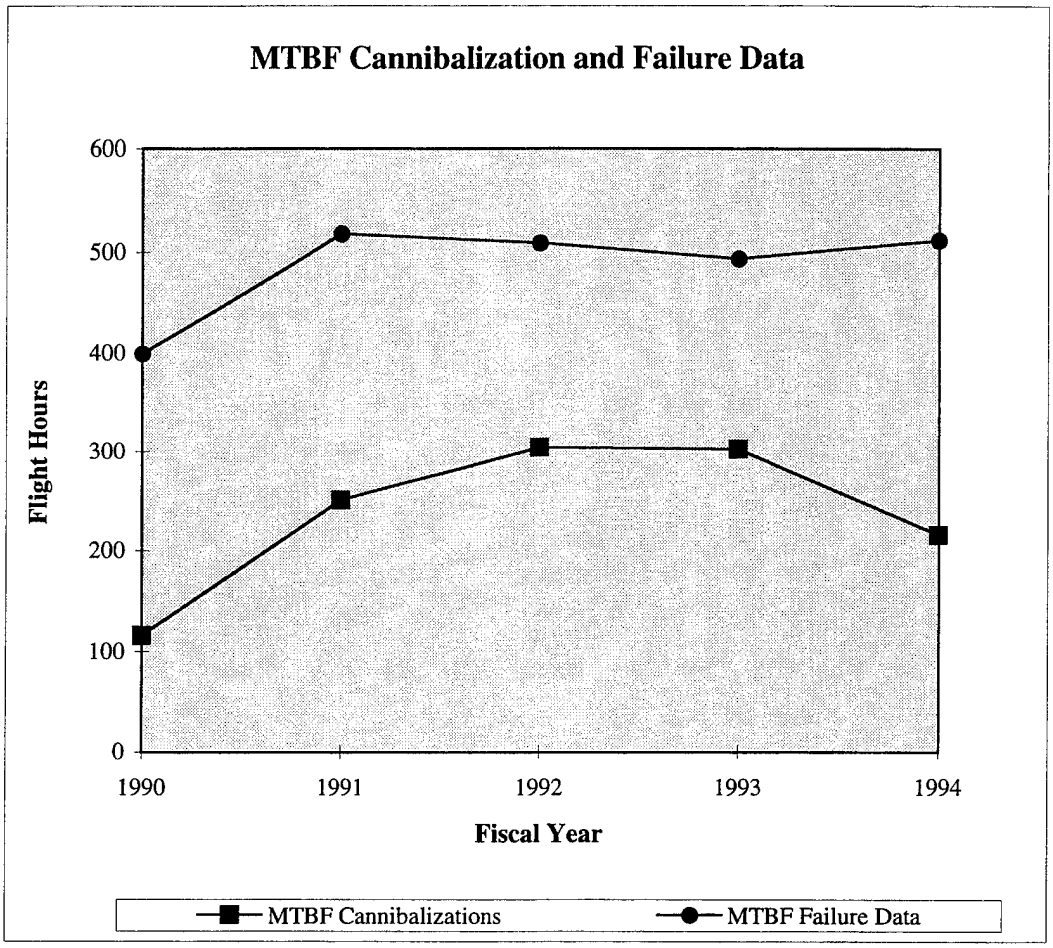


Figure 4. MTBF for Cannibalization Data and All Failure Data

b. Does Engine Cannibalization Have Less Adverse Impact on TF34 MTBF in the Most Recent Years?

The results of the analysis given in Table 3 indicate that the MTBF for engines that were cannibalized then followed by a failure did improve in 1991 and 1992, but appears to have declined in 1994.

3. New Engine Purchase Fiscal Year 1992

During the FY92, 50 new TF34 engines were purchased to alleviate engine and spare part shortages. [Ref. 6] This purchase had a dramatic effect on the number of engines that were cannibalized in the following years, see Figure 3 Section F of this chapter. However, the purchase of 50 new TF34 engines did not appear to have a significant impact on MTBF on engines that were cannibalized then followed by a failure. The data also indicated no appreciable effect on MTBF for the engine failure database which remained relatively constant for the following years.

III. IS MTBF A FUNCTION OF THE NUMBER OF PREVIOUS REPAIRS?

A. THE TRUE FAILURE DATA SET

To answer the question as to whether the MTBF of an engine depends on the number of previous repairs, the data set, actual engine failures described in Chapter II, Section A, was sorted to produce a new data set that had no zero FHSR entries in the database. The initial data set consisted of 697 records with 38 of these records having a zero FHSR entry. These zero entries were deleted to enable the data set to represent true failure times after "t" operating hours. This data set shall be referred to as the True Failure data set.

1. Failure Time Categories

The data was first sorted by engine serial number and start date (engine removal date). This resulted in a chronological removal history for each engine serial number in the data set, see Appendix C. To distinguish whether an engine was on its first, second, third, or fourth successive repair, the chronological engine records were coded 1, 2, 3, 4 respectively. This coding now enabled the data to be sorted into categories labeled First, Second, Third, and Fourth time removed for repair since FY90. The First category FHSR records were truncated at 1500 hours resulting with 328 records for this category. Each category could now be analyzed with previous methods, Non-Parametric and Weibull Distribution analysis. The resulting parameters are presented in Table 4.

FIRST REPAIR

FY90-94 TF	# of records	BETA	THETA	MTBR	STD DEV
Weibull - All	328	1.7536	705.91	628.60	369.88
Nonpara - All	328			609.68	406.48
Weibull - less 10%	295	2.022	774.04	685.76	358.99
Nonpara - less 10%	295			672.69	379.57
Weibull - less 50% <100	312	1.8791	739.04	655.95	361.36
Nonpara - less 50% <100	312			639.95	393.54
Weibull - less 80% <100	302	1.9619	759.66	673.50	358.39
Nonpara - less 80% <100	302			659.14	385.34

SECOND REPAIR

FY90-94 TF	# of records	BETA	THETA	MTBR	STD DEV
Weibull - All	213	1.083	397.34	384.93	357.79
Nonpara - All	213			383.26	362.63
Weibull - less 10%	192	1.2479	460.55	428.95	345.31
Nonpara - less 10%	192			424.67	358.43
Weibull - less 50% <100	181	1.3435	494.66	453.30	342.82
Nonpara - less 50% <100	181			449.18	354.66
Weibull - less 80% <100	161	1.5391	558.89	503.07	333.70
Nonpara - less 80% <100	161			498.86	344.99

THIRD REPAIR

FY90-94 TF	# of records	BETA	THETA	MTBR	STD DEV
Weibull - All	86	1.1937	353.76	333.45	281.21
Nonpara - All	86			330.40	288.14
Weibull - less 10%	77	1.3606	404.05	369.57	275.61
Nonpara - less 10%	77			368.10	281.23
Weibull - less 50% <100	74	1.4192	421.02	382.56	274.38
Nonpara - less 50% <100	74			381.86	278.22
Weibull - less 80% <100	68	1.5405	455.24	409.77	271.81
Nonpara - less 80% <100	68			410.62	272.01

FOURTH REPAIR

FY90-94 TF	# of records	BETA	THETA	MTBR	STD DEV
Weibull - All	22	1.0402	345.66	340.04	326.52
Nonpara - All	22			339.18	331.13
Weibull - less 10%	20	1.2068	401.48	377.27	314.53
Nonpara - less 10%	20			372.85	328.73
Weibull - less 50% <100	18	1.3994	458.99	417.94	303.73
Nonpara - less 50% <100	18			412.61	322.54
Weibull - less 80% <100	16	1.6304	518.94	464.28	293.45
Nonpara - less 80% <100	16			460.75	309.26

Table 4. Non-Parametric and Weibull Distribution Parameters

2. Cumulative Distribution Functions of the True Failure Data

Table 4 represents both the Non-Parametric and Weibull parameters, MTBF and associated values for the True Failure data set. These categories are similar to Table 1 in Chapter II. However, there is no "less-zero" category because all zero records were deleted. The values beta, theta, MTBF, and Standard Deviation (STD DEV) were computed as described in Chapter II.

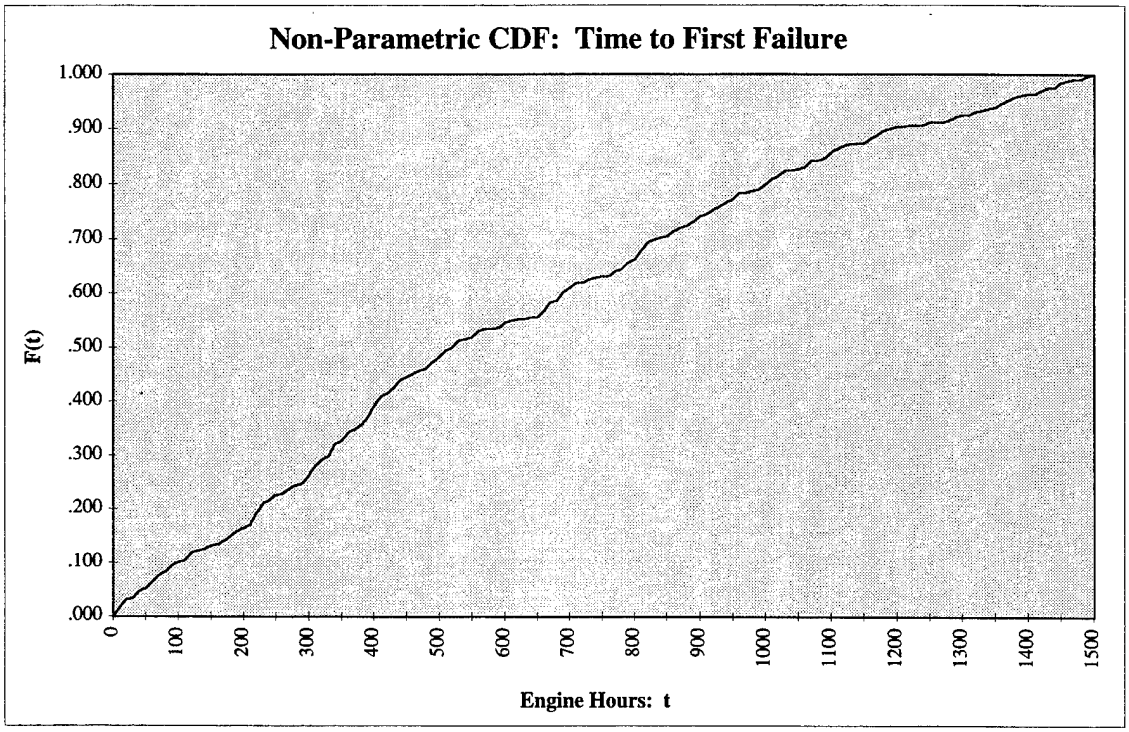
There is a significant difference between the first repair MTBF and all subsequent repair MTBFs. The engines making their first shop visit for repair have an MTBF of 628 hours (Weibull-All Table 4). By comparison, the subsequent shop visits display a significantly reduced MTBF, namely the Second data set has a MTBF of 385 hours, the Third data set has a MTBF of 333 hours, and the Fourth data set has a MTBF of 340 hours for the same "All" category. This is an indication of a minimum repair being accomplished. For example, an engine removed for a high time High Pressure Turbine (HPT) will be inducted to the Intermediate Maintenance Activity (IMA) and receive a Major Engine Inspection (MEI). All engines upon induction to the IMA are required to have a MEI. In this inspection, an engine undergoes a visual inspection including a borescope inspection of the entire engine.[1] This inspection could reveal cracks in the combustor that are not out of limits in accordance with the Maintenance Instruction Manuals (MIMs). Consequently, these cracks are only close to rejection and the combustor is not repaired. The high-time component, the HPT, which is the original engine discrepancy, is removed and replaced and the engine is returned to service. The HPT now has 1500 operating hours remaining and the combustor cracks may have only 500 hours remaining. Hypothetically, the engine will return to the IMA when the combustor fails. It is interesting to note that the MTBFs of

[1] A borescope inspection is where the technicians inspect the internal areas of the engine. A borescope is a fiberoptic instrument that can be inserted through a small access and allow the inspector to view inside the engine without disassembly.

the second, third and fourth consecutive repairs remain close to the IMA no-build time of 350 hours. Figure 5 graphically compares the Non-Parametric Cumulative Distribution Function (CDF) and the Weibull CDF of the individual data sets First, Second, Third, and Fourth.

3. Comparison of Analysis Methods

The Non-Parametric and the Weibull fit reveal some inconsistencies with the First data set. The remaining data sets display a relatively good fit to the respective data. The First data set requires more information and analysis to determine a more accurate fit of a probability distribution to the population of engines.



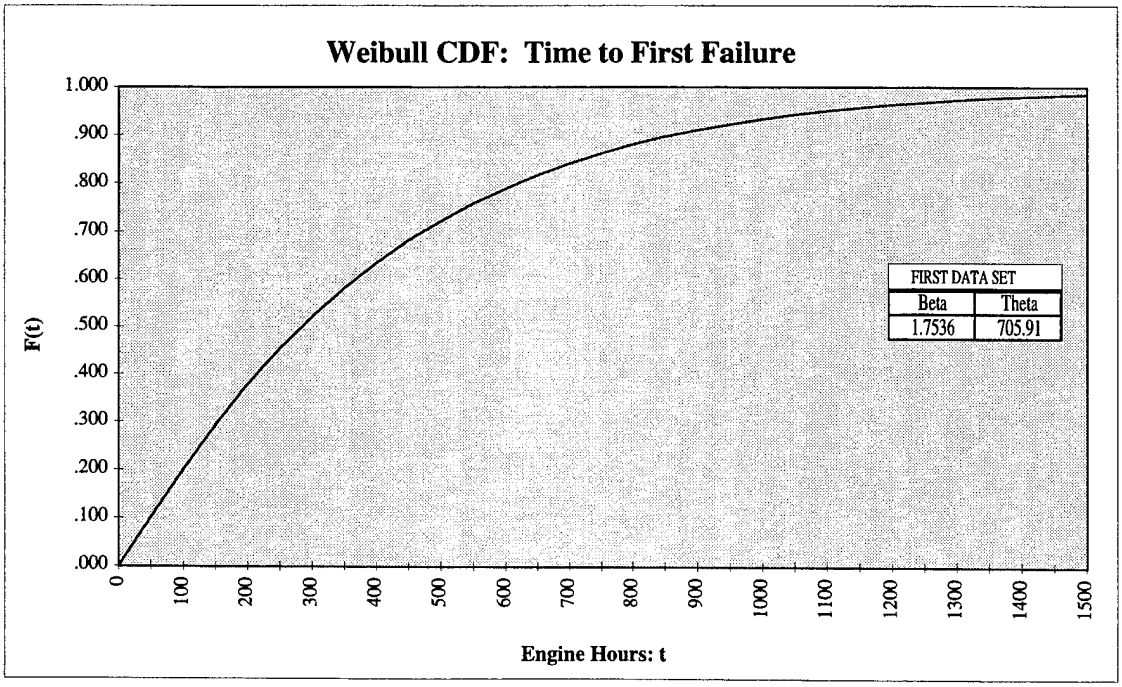
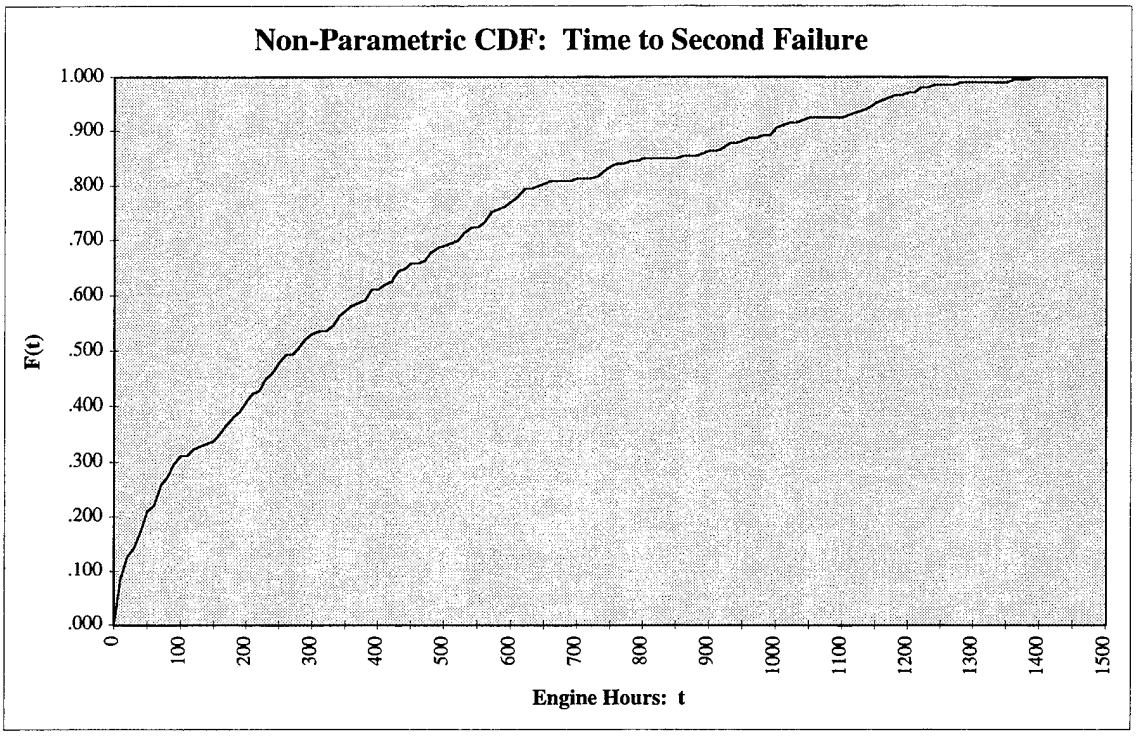


Figure 5. CDF of the True Failure Data Sets



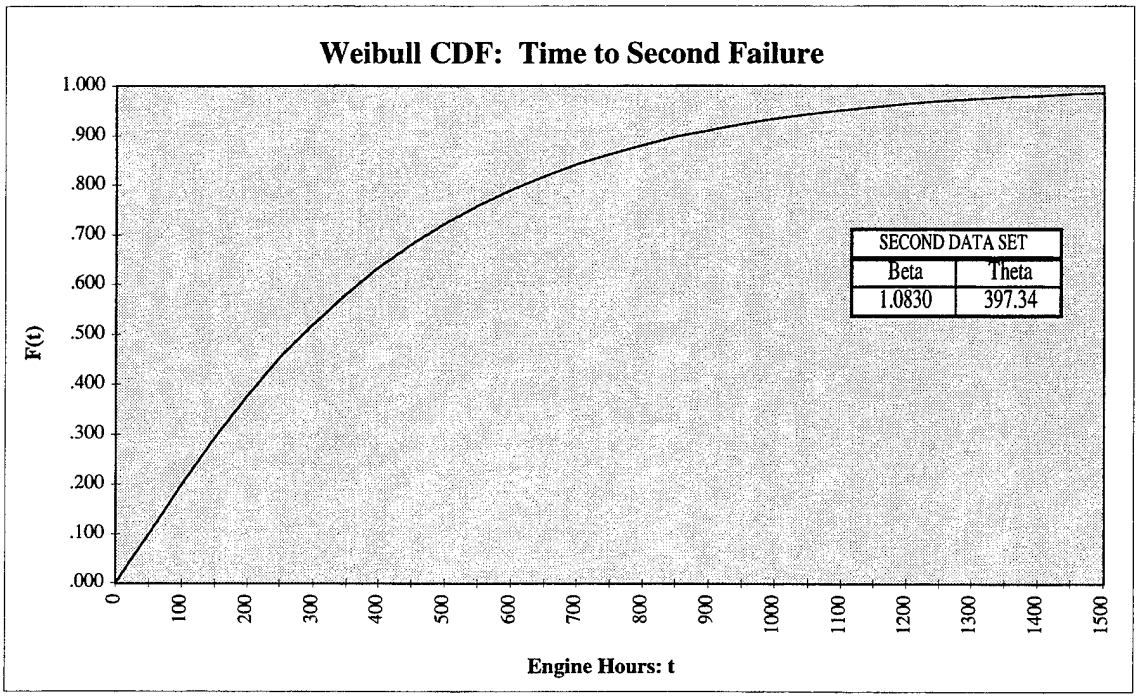
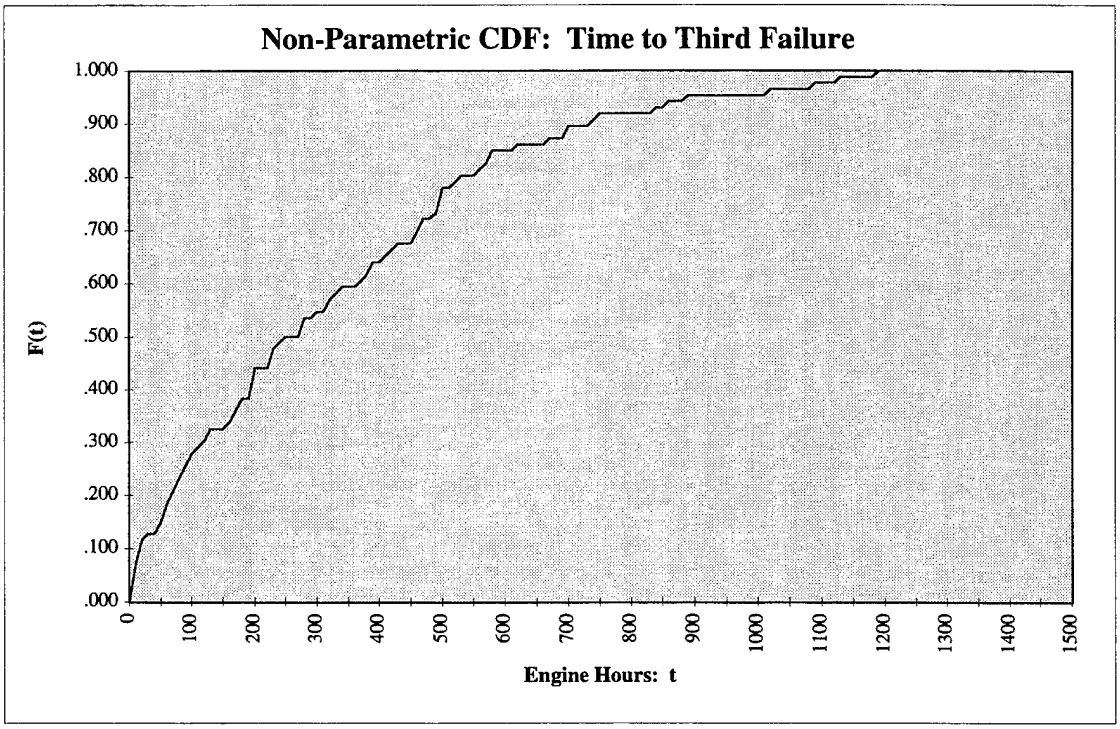


Figure 5. CDF of the True Failure Data Sets



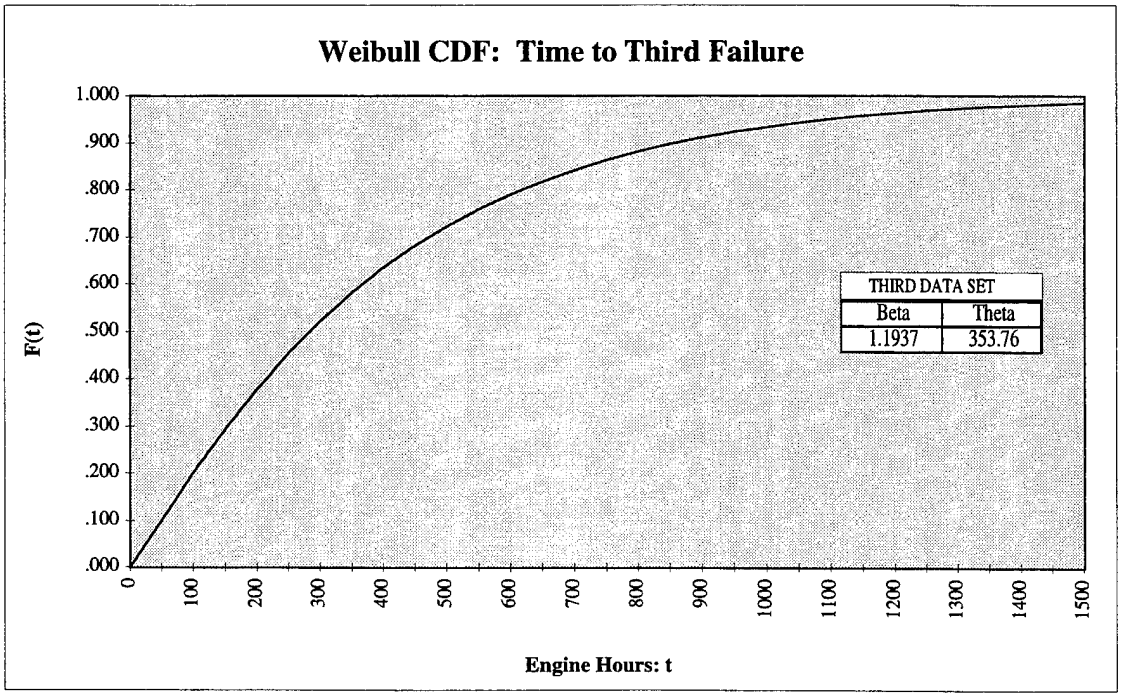
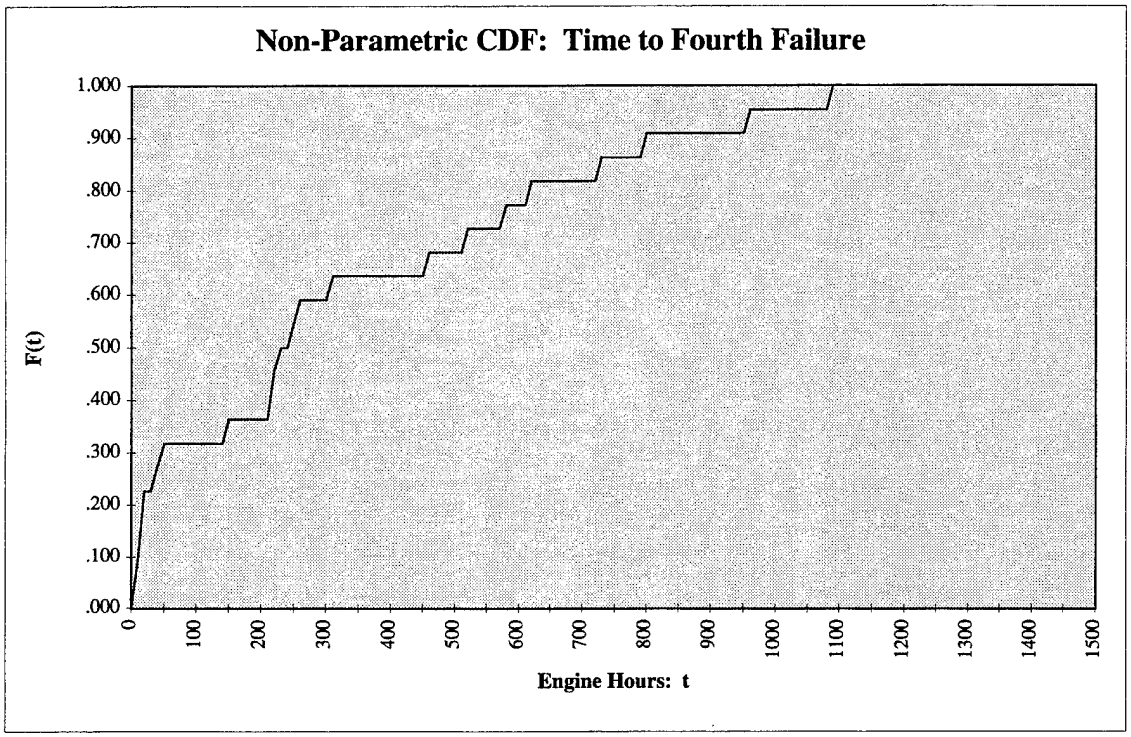


Figure 5. CDF of the True Failure Data Sets



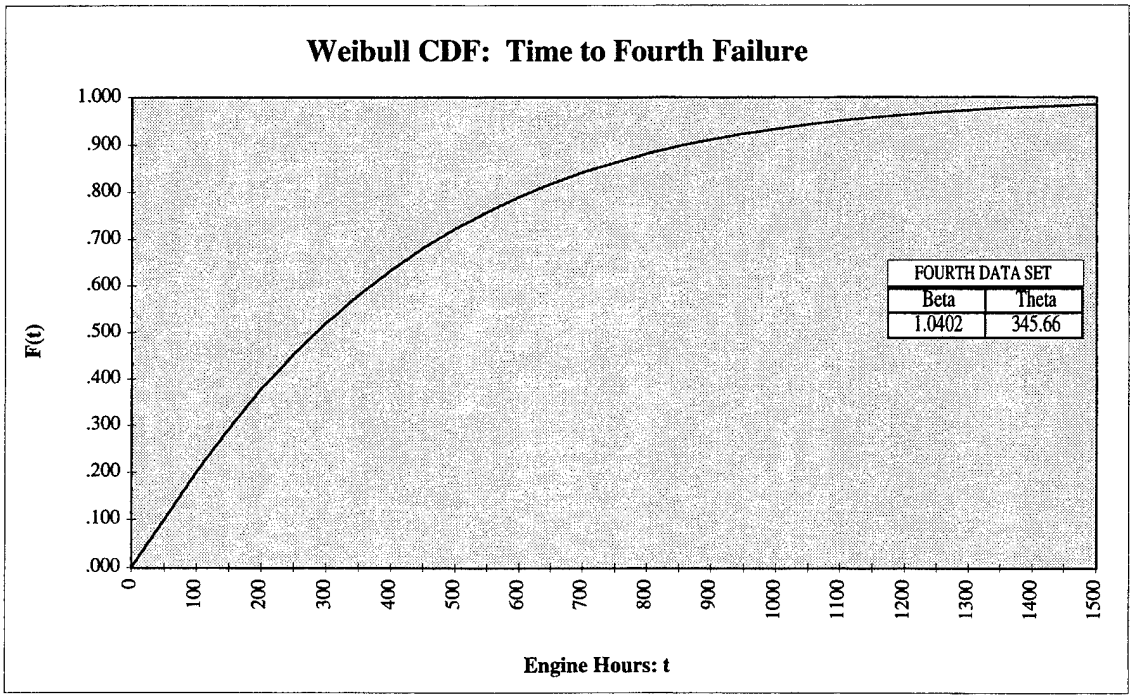


Figure 5. CDF of the True Failure Data Sets

4. The Probability Density Function of the True Failure Data

Section D of Chapter II explained the Weibull distribution and how it is characterized by two parameters, θ and β. If $\beta = 1$, then the Weibull distribution is an Exponential distribution.

The Weibull PDF values have been computed for the First, Second, Third and Fourth repair data sets with respect to their theta and beta parameters and are presented in Table 5 followed by a graphical representation in Figure 6. It is evident that the First data set represents a different distribution than the Second, Third or the Fourth data sets. The distribution of the First data set more closely resembles a Weibull distribution. The Second through Fourth data sets more closely represent an Exponential distribution.

Failure t	FIRST Repair	SECOND Repair	THIRD Repair	FOURTH Repair
50	0.00033	0.00206	0.00210	0.00244
100	0.00055	0.00194	0.00212	0.00217
150	0.00072	0.00177	0.00200	0.00191
200	0.00086	0.00160	0.00182	0.00167
250	0.00097	0.00143	0.00163	0.00145
300	0.00104	0.00127	0.00144	0.00126
350	0.00109	0.00113	0.00125	0.00109
400	0.00112	0.00100	0.00109	0.00095
450	0.00112	0.00088	0.00093	0.00082
500	0.00111	0.00077	0.00080	0.00070
550	0.00108	0.00068	0.00068	0.00061
600	0.00104	0.00059	0.00057	0.00052
650	0.00098	0.00052	0.00048	0.00045
700	0.00092	0.00045	0.00040	0.00039
750	0.00086	0.00039	0.00034	0.00033
800	0.00079	0.00034	0.00028	0.00028
850	0.00072	0.00030	0.00023	0.00024
900	0.00065	0.00026	0.00019	0.00021
950	0.00058	0.00022	0.00016	0.00018
1000	0.00051	0.00019	0.00013	0.00015
1050	0.00045	0.00017	0.00011	0.00013
1100	0.00039	0.00015	0.00009	0.00011
1150	0.00034	0.00013	0.00007	0.00010
1200	0.00029	0.00011	0.00006	0.00008
1250	0.00025	0.00009	0.00005	0.00007
1300	0.00021	0.00008	0.00004	0.00006
1350	0.00018	0.00007	0.00003	0.00005
1400	0.00015	0.00006	0.00003	0.00004
1450	0.00012	0.00005	0.00002	0.00004
1500	0.00010	0.00004	0.00002	0.00003
1550	0.00008	0.00004	0.00001	0.00003
1600	0.00007	0.00003	0.00001	0.00002
1650	0.00006	0.00003	0.00001	0.00002
1700	0.00005	0.00002	0.00001	0.00002
1750	0.00004	0.00002	0.00001	0.00001
1800	0.00003	0.00002	0.00000	0.00001
1850	0.00002	0.00002	0.00000	0.00001
1900	0.00002	0.00001	0.00000	0.00001
1950	0.00001	0.00001	0.00000	0.00001
2000	0.00001	0.00001	0.00000	0.00001

True Failure Data Set

	Beta	Theta
FIRST	1.7536	705.91
SECOND	1.0830	397.34
THIRD	1.1937	353.76
FOURTH	1.0402	345.66

Table 5. Weibull PDF of True Failure Data Set

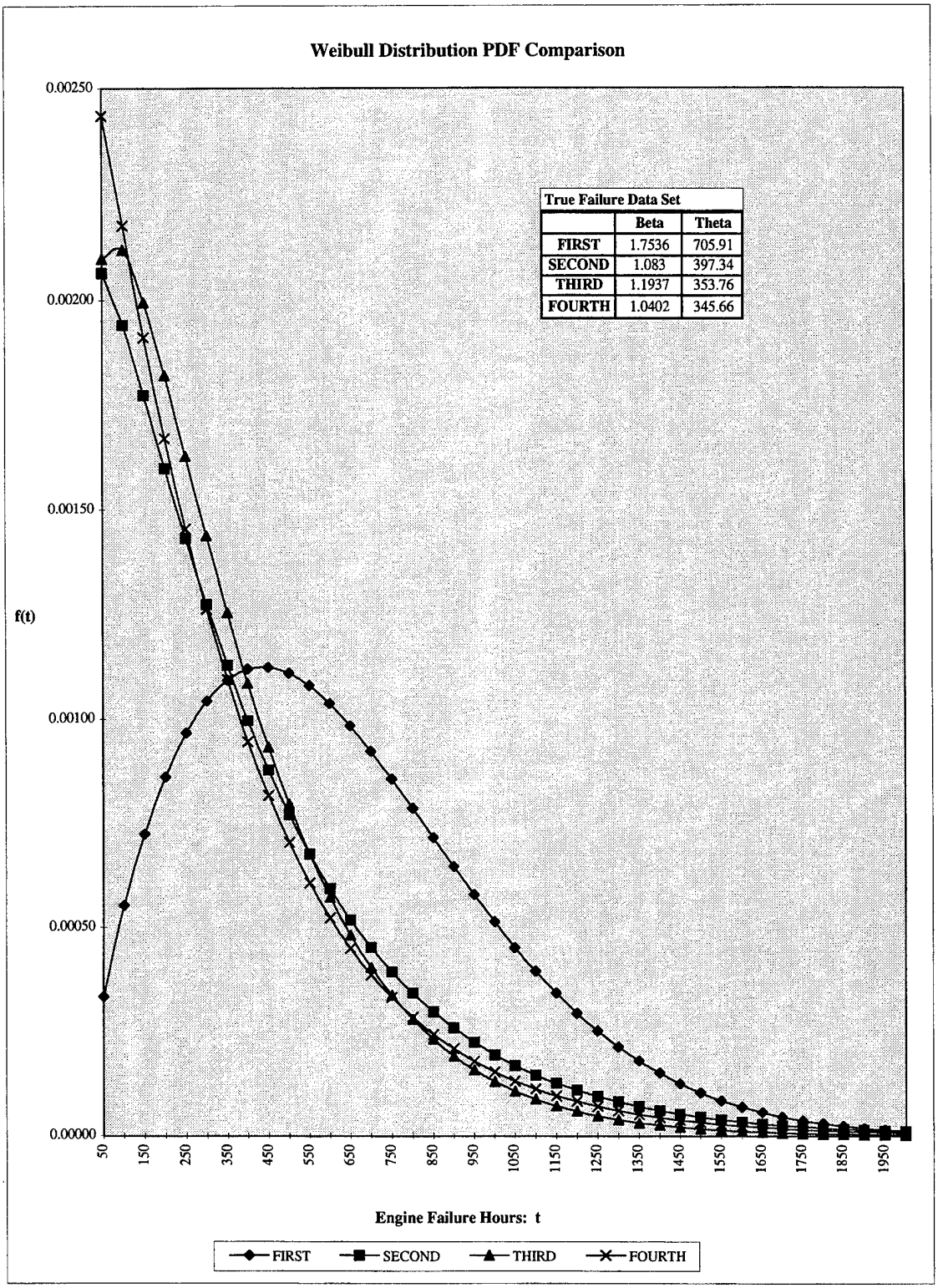


Figure 6. Weibull Distribution PDF

IV. SETTING INSPECTION TIMES AND NO-BUILD TIMES

A. ENGINE INSPECTION TIMES

1. Life Limited Components

A significant factor impacting scheduled maintenance of a TF34 engine is that many of the components have designated limited operating times (high-times). When these components reach their high-times, they must be inspected or replaced. These components are also known as high-time components. The TF34 engine system has five major subsystems. They are the Fan Rotor, Compressor Rotor, Combustor, High Pressure Turbine (HPT) Rotor, and the Low Pressure Turbine (LPT) Rotor. Each subsystem is made up of numerous subassemblies, such as, turbine blade sets, cooling plates and turbine disks. One of the largest challenges in building TF34 engines from spare components in the maintenance process, is to select the combination of different components that will result in longest life before next engine removal. A listing of TF34 engine subsystems and subassemblies is provided in Table 6. [Ref. 8] Selecting a combination of components to build an engine during maintenance is further complicated by the fact that many of the components have several versions (different part numbers) of the same replacement part, all having a different life limit.

NOMENCLATURE	PART NUMBER	DISPOSITION	OPERATING HOURS
FAN ROTOR	**ALL**	Repair at Depot	
Fan Disk	6020T62G02	Scrap at Depot	3300 see note 3
Fan Disk	6020T62G03/04/05	Repair at Depot	4750 see note 3
Fan Disk	6016T32G03/05	Scrap at Depot	3300 see note 3
Fan Disk	5920T88G03/04/06/07	Scrap at Depot	3300 see note 3
Fan Disk	5920T88G02/05	Repair at Depot	4750 see note 3
Fan Disk	5921T18G01/02/03/0 /10	Scrap at Depot	4500 TSR see note 3
Fan Disk	6078T00G01	Repair at Depot	4750 see note 3
Fan Drive Shaft	6019T44P02GSI/P03GSI	Scrap at Depot	7800 see note 3
Fan Drive Shaft	6019T44P02/P03	Insp. at Depot	4500 see note 3
Fan Drive Shaft	6030T54G01GSI	Scrap at Depot	7800 see note 3
Fan Drive Shaft	6030T54G01	Insp. at Depot	4500 see note 3
Fan Drive Shaft	6036T78P02	Scrap at Depot	13700 see note 3
Fan Blade	6018T30P02/03	Scrap at Depot	4800 see note 3
Fan Forward Shaft	6017T63P01/03/04	Scrap at Depot	15000 see note 3
COMPRESSOR ROTOR	**ALL**	Repair at Depot	see note 2
Forward Shaft	5037T01P02	Scrap at Depot	15000 see note 3
Stage 1 Disk	6017T54P02/03	Scrap at Depot	8000 see note 3
Stage 1 Disk	5920T44P02	Scrap at Depot	8000 see note 3
Stage 1 Disk	6037T01P01	Scrap at Depot	7000 see note 3
Stage 2 Disk	6017T66P01/03	Scrap at Depot	8000 see note 3
Stage 2 Disk	5920T81P01	Scrap at Depot	7000 see note 3
Stage 2 Disk	6036T91P01	Scrap at Depot	7000 see note 3
Stage 3 - 8 Spool	**ALL**	Scrap at Depot	12300 see note 3
Stage 9 Disk	6016T43P03	Scrap at Depot	12000 see note 3
Stage 10 - 14 Spool	6020T65P01/P02	Scrap at Depot	7100 see note 3
Rear Shaft	6016T83P01	Scrap at Depot	9000 see note 3
Rotating Seal	4019T38P01	Scrap at Depot	15000 see note 3
COMBUSTOR	**ALL**		
Combustion Chamber Frame	6021T72G03	Scrap at Depot	7500 ** see note 1
Combustion Chamber Frame	5038T17G01	Scrap at Depot	7500 ** see note 1
Combustion Chamber Frame	6021T72G06/10	Scrap at Depot	7500 ** see note 1
Combustion Chamber Frame	5920T97G01 thru 05	Scrap at Depot	7500 ** see note 1

** fluropenetrant inspection required at 1500 hour intervals, thereafter

NOTES:

1. Inspection required at 1500 hour intervals. Scrap on condition.
2. Removal interval based on lowest life remaining part in assembly.
3. No extension allowed.
4. Life limit anticipated greater than 15,000 hours.

Table 6. Life Limits

NOMENCLATURE	PART NUMBER	DISPOSITION	OPERATING HOURS
HPT ROTOR	**ALL**	Repair at Depot	see note 2
Forward Shaft	6017T00P03	Scrap at Depot	15000 see note 3
Balance Rotating Piston Seal	5025T33P03/04	Scrap at Depot	12000 see note 3
Stg. 1 Fwd Cooling Plate	4027T15P02	Scrap at Depot	9000
Stage 1 Turbine Disk	6031T89P02	Scrap at Depot	12000 see note 3
Stage 1 Turbine Disk	3921T50P01	Scrap at Depot	12000 see note 3
Stage 1 Turbine Disk	6031T89P01	Scrap at Depot	9870 see note 3
Stage 1 Turbine Disk	5025T23P01	Scrap at Depot	4500 see note 3
Stg. 1 Turbine Blade	6016T19PO4	Scrap at Depot	1500
Stg. 1 Turbine Blade	6016T20G05	Scrap at Depot	1500
Stg. 1 Turbine Blade	6040T44G14	Scrap at Depot	3000
Stg. 1 Aft Cooling Plate	5025T95P01, /A	Scrap at Depot	1500
Stg. 1 Aft Cooling Plate	5041T70P01, /A	Scrap at Depot	4500
Stg. 1 Aft Cooling Plate	5041T70P03, /A	Scrap at Depot	15000
Torque Coupling - Pancake	5026T11P02	Scrap at Depot	1500
Torque Coupling - Contour	5026T11P02	Scrap at Depot	3200
Torque Coupling	4021T18P03	Scrap at Depot	1500 see note 3
Inner Torque Coupling	5041T66P02	Scrap at Depot	8000 see note 3
Outer Torque Coupling	5041T67P02	Scrap at Depot	13000
Stg. 2 Fwd. Cooling Plate	5021T77P01, /A	Scrap at Depot	1500 see note 3
Stg. 2 Fwd. Cooling Plate	5042T29P01, /A	Scrap at Depot	13000
Stg. 2 Fwd. Cooling Plate	3921T53P01A	Scrap at Depot	13000
Stg. 2 Fwd. Cooling Plate	3921T57P01	Scrap at Depot	1500 see note 3
Stg. 2 Fwd. Cooling Plate	3921T57P01A	Scrap at Depot	1500 see note 3
Stg. 2 Turbine Disk	6031T90P01	Scrap at Depot	5800
Stg. 2 Turbine Disk	6031T90P02	Scrap at Depot	8000 see note 3
Stg. 2 Turbine Disk	3921T51P01	Scrap at Depot	8000 see note 3
Stg. 2 Turbine Disk	5026T10P01	Scrap at Depot	4500 see note 3
Stg. 2 Aft Cooling Plate	5023T97P02	Scrap at Depot	9000 see note 3
Stg. 2 Aft Cooling Plate	3921T54P01	Scrap at Depot	9000 see note 3 see note 2

** fluropenetrant inspection required at 1500 hour intervals, thereafter

NOTES:

1. Inspection required at 1500 hour intervals. Scrap on condition.
2. Removal interval based on lowest life remaining part in assembly.
3. No extension allowed.
4. Life limit anticipated greater than 15,000 hours.

Table 6. Life Limits (continued)

	PART NUMBER	DISPOSITION	OPERATING HOURS
LPT ROTOR	5026T20G03/05	Repair at Depot	
Drive Cone	5023T40P01	Scrap at Depot	15000
Stg. 3 Turbine Disk	3920T56P01	Scrap at Depot	6100
Stg. 3 Turbine Disk	5026T16P01/02	Scrap at Depot	15000
Stage 3 - 4 Seal	5023T59P02	Scrap at Depot	15000
Stage 3 - 4 Seal	5023T59P03	Scrap at Depot	8900
Stage 4 Turbine Disk	5023T42P02/03	Scrap at Depot	4500
Stage 4 Turbine Disk	5026T17P02/03	Scrap at Depot	6000 see note 3
Stage 4 - 5 Seal	5038T56P01	Scrap at Depot	15000
Stage 4 - 5 Seal	5023T67P01	Scrap at Depot	15000
Stage 5 Turbine Disk	5024T53P01/02	Scrap at Depot	15000
Stage 5 - 6 Seal	5023T64P02	Scrap at Depot	15000
Stage 6 Turbine Disk	5023T45P03/04	Scrap at Depot	15000
Stage 6 Turbine Disk	3290T57P01	Scrap at Depot	15000
Rear Shaft	6030T72P02	Scrap at Depot	15000

** fluropenetrant inspection required at 1500 hour intervals, thereafter

NOTES:

1. Inspection required at 1500 hour intervals. Scrap on condition.
2. Removal interval based on lowest life remaining part in assembly.
3. No extension allowed.
4. Life limit anticipated greater than 15,000 hours.

Table 6. Life Limits (continued)

2. No-Build Times and Hard Inspection Times

The technicians at the IMA and the Depot have certain criteria that constrains the assembly of an engine. At the IMA, an engine will not be assembled if the combination of available components to build it result in an engine whose remaining operating time before next scheduled removal is less than 350 hours. At the Depot, an engine will not be assembled if the combination of available components would yield an engine whose operating time before next scheduled removal is less than 500 hours. [Ref. 8] These constraining time values are commonly known as no-build times among maintenance personnel. Table 6 lists several notes that further complicate this matter. Note 1 pertains solely to the Combustor. It states that the Combustor must be inspected every 1500 hours. Moreover, the Combustor must have a fluropenatrant inspection at every 1500 hour interval. Along with the HPT, the maximum operating time any engine stays on an aircraft wing is 1500 hours. In a Reliability Centered Maintenance Program, these items are called hard build times, the field activities try to manage all Life Limited components and assemble engines with the goal of maximizing operating hours. The primary purpose of this chapter is to present a methodology for computing no-build time of a Significant Item (SI) given its Hard Time (HT) and maintenance cost factors.

B. RELIABILITY CENTERED MAINTENANCE (RCM)

Reliability Centered Maintenance is a formal methodology used to identify what preventative maintenance tasks should be done and when they should be done in order to obtain the inherent reliability of equipment at the least expenditure of resources. [Ref. 9: p. ii] One major function in an RCM program is to identify Significant Items that should have hard inspection times called Hard Times.

1. Significant Item Determination

A function performed early in RCM is the determination of Significant Items (SI). These items are subsystems or subassemblies. SI items are identified by performing a Failure, Mode, Effects and Criticality Analysis. [Ref. 9]

2. Setting Hard Inspection Times

A hard inspection time for an SI item is the scheduled removal of all units of the item before some specified maximum age limit, to prevent functional failure. [Ref. 9: p. 4-8] The Defense Technical Information Center, Defense Logistics Agency, Technical Report [Ref. 10] and the Naval Air Systems Command, "RCM ANALYSTS COURSE," [Ref. 9] provide procedures for identifying components that should have Hard Time (HT) inspection times. Components not having HT inspection times have On-Condition inspection times. Several optimization criteria (formulas) for determining HT inspection times are provided in each of these two RCM manuals. The inspection policy for an aircraft engine and its components is established in part by specifying the HT times for the appropriate SI items and the inspection procedures for the other On-Condition inspection items.

Maintenance policies formulated in this manner will have a consequent mix of engines that are inspected due to a failure and engines that are inspected by direction (without failure). Whatever this mix is, it is the appropriate mix if the optimization criteria used to determine the HT times is appropriate and the maintenance program is administered properly. The criteria for setting HT times will use time to failure distributions of these SI items and their associated reliability (probability of survival) and residual reliability (conditional probability of survival) expressions. Equations for these expressions were developed in Caudill's thesis [Ref. 2] and appear in Appendix B of this thesis in summary

form. These same expressions are appropriate for computing the reliability and residual reliability for any component using failure time data for that component.

It would not be appropriate to establish an "optimum" mix of scheduled and unscheduled engine removals using just mean-time-to-removal of engines and average repair costs. The maintenance program is too complex. The maintenance policy should be established accounting for safety, mission, engine design, component reliability, component residual reliability (time-related reliability) cost of maintenance actions and their benefit to component residual reliability, and other factors. RCM methodology is designed to account for these factors.

C. ESTABLISHING NO-BUILD TIMES

In this section, a procedure is provided for determining the no-build time for a failed engine relative to the inspection Hard Times, HT, of its SI components. Suppose an engine has failed and an SI component with an HT time of T_0 hours has accumulated t_0 operating hours at the time of the engine failure. If $T_0 - t_0$ is sufficiently small, then the engine should not be rebuilt/repaired and returned to service without also performing the inspection/rebuild on the SI component which was intended to be done when T_0 operating hours had been accumulated. The lower limit of $T_0 - t_0$ for which a no-build decision is made is called the no-build time. Use of no-build times in a maintenance policy can save resources by performing maintenance on SI components while an engine is under repair for another purpose.

In this section, equations are provided for determining a cost-effective no-build value of t_0 given T_0. The method uses repair cost data and the failure time density functions of the HT component and the TF34 engine and their associated reliabilities and residual reliabilities.

The following notation is needed:

T_0 :	HT time for the SI component.
T :	Random failure time of SI component.
f(t):	Failure density function for the SI component.
F(t):	$P(T \leq t)$.
$\bar{F}(t)$:	$P(T>t)$, reliability of SI component.
$\bar{F}(T_0 \backslash t_0)$:	$P(T>T_0 \backslash T>t_0)$, residual reliability of SI component.
IR :	Inspect/Repair.
C_N:	IR cost of SI component at time of engine failure not due to SI component failures.
C_I :	IR cost of SI component in a non-failed engine. Usually $C_N < C_I$.
T_e :	Time to failure of TF34 engine.
$f_e(t)$:	Failure density function for the TF34 engine.
$F_e(t)$:	$P(T_e \leq t)$.
$\bar{F}_e$:	$P(T_e>t)$, reliability of TF34 engine.

The scenario for deciding whether or not to inspect/repair an SI component at the time of engine failure can be explained using Figure 7. Given the parent engine has failed at time t_e and the SI component has accumulated t_0 operating hours and its HT time is T_0 hours, the SI

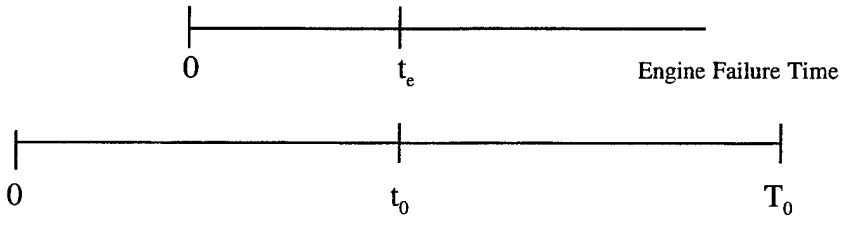


Figure 7. SI Component Operating Time

component should undergo IR now if the cost per unit of operating time is less than the average repair cost per unit of operating time if inspection is delayed until another engine failure or until it has accumulated T_0 operating hours. The approximate optimum time, t_0, is the solution for t_0 in the equation.

$$\frac{C_N}{t_0} = \left[C_N \int_0^{T_0 - t_0} \frac{1}{t_0 + t} f_e(t)dt + \frac{C_I}{T_0} \overline{F}_e(T_0 - t_0) \right] \overline{F}(T_0 \backslash t_0) \qquad (7)$$

This equation is derived and discussed in Appendix D. It assumes that $\overline{F}(T_0 \backslash t_0)$ is close to one. The expression C_N/t_0 is the IR cost per unit operating time if IR is done at time of engine failure. The right hand member of equation (7) is the expected IR cost per unit operating time if IR is not done at time of engine failure. The solution for t_0 in equation (7) makes these costs per unit time equal. Therefore, if at time of engine failure, the accumulated operating time, t, on the SI component is less than t_0, IR should not be done on the SI component at time of engine failure. Rather, one should take the chance that another engine failure will occur before time T_0 - t has been accumulated on the engine, thus offering a better time to perform the IR on the SI component.

An alternative approach to solving equation (7) directly is to assume that $\overline{F}_e(T_0 - t_0)$ is close to one. This means the term with the integral sign in equation (7) is very small.

In this case, solve for t_0 in the equation:

$$\frac{C_N}{t_0} = \frac{C_I}{T_0} \overline{F}(T_0 \setminus t_0) \qquad (8)$$

After t_0 is computed using equation (8), compute $\overline{F}_e(T_0 - t_0)$ to see if it is close to one. If it is then use t_0 obtained from equation (8) as the solution to equation (7). If not, then equation (7) should be used to determine t_0.

D. EXAMPLE SOLUTION FOR t_0

Suppose $F(t) = e^{-(t/\theta)^{\beta}}$ where θ and β have been estimated using failure time data for an SI component. Then $\overline{F}(T_0 \backslash t_0) = e^{-(T_0/\theta)^{\beta}} e^{(t_0/\theta)^{\beta}}$. Suppose θ = 10,000 and β = 1.5. Also suppose $C_N/C_I = .47$ and $T_0 = 1000$ hours. Using equation (8) to solve for t_0 :

$$\frac{C_N}{t_0} = \frac{C_I}{t_0} e^{-(T_0/\theta)^{\beta}} e^{(t_0/\theta)^{\beta}} \tag{9}$$

so that

$$T_0 \frac{C_N}{C_I} e^{(T_0/\theta)^{\beta}} = t_0 e^{(t_0/\theta)^{\beta}} \tag{10}$$

thus

$$1000(.47)\ e^{(.1)^{1.5}} = t_0 e^{[t_0/10{,}000]^{1.5}} \tag{11}$$

or

$$546.06 = t_0 e^{[t_0/10{,}000]^{1.5}}$$

By trial and error

$$t_0 = 506 \tag{12}$$

The reliability of a TF34 engine at 506 hours (θ = 500, β = 1.5); i.e. $\overline{F}_e(506)$ is .3613, which is not close to one. Therefore, equation (7) should be used to solve for t_0 to get a larger value for t_0.

1. Spreadsheet Procedures for Solving t_0

The trial and error solution process for t_0 is a somewhat difficult. A spreadsheet template has been constructed to facilitate the calculations and is presented on Table 7. The solution for t_0 is accomplished by using the Goal Seek tools in Excel. Appendix B contains the spreadsheet procedures for using this template.

Variable Description	Variable	Data Entry
High Time for the HT Component:	T_0	1000
Accumulated Time	t_0	506.14
Cost of Inspecting HT Component at Time of Engine Failure	C_N	470
Cost of Inspecting HT Component in a Non-Failed Engine	C_I	1000
Beta	Beta	1.5
Failure Rate	Lambda	0.0001

Trial
1000.00

Table 7. t_0 Solution Template

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

The analyses performed in this thesis addressed the following questions:

- Has engine cannibalization had an increased adverse impact on MTBF of the TF34 engines in the most recent years?
- Does the reliability of TF34 engines decrease with the number of repair actions?
- How can conditional survival probabilities of Significant Items (components) and reliabilities of the TF34 engine be used to compute their cost-effective no-build times given their maximum operating time using Reliability Centered Maintenance concepts?
- What are the conditional and non-conditional reliability values and the MTBF of select sub-populations of the 5-year NALDA TF34 engine data base and how can this information be used to modify maintenance policy to increase the TF34 engine MTBF and reliability?

B. CONCLUSIONS

1. Analyses in this thesis demonstrates that current cannibalization maintenance policies (FY93-94) have resulted in a lower MTBF for cannibalized TF34 engines for the FY93-94 time period than the corresponding MTBF values for 1992.

2. The large member of low failure times of repaired engines has a significant influence on MTBF of the TF34 engine. The number of zero time to failure values in the data base has decreased in the most recent years (FY93-94). A maintenance policy that targets eliminating zero failure times and 80% of the failure times less than 100 hours could increase MTBF as much as 19%.

3. The MTBF of TF34 engines is a function of the number of previous repairs. The MTBF of engines undergoing their first repair is about 44% larger than the average MTBF of engines undergoing their second, third, or fourth repair.

4. Mathematical equations were developed that can be used to compute cost-effective no-build times for Significant Items (SI) (i.e. components) of the TF34 engine. These equations use conditional survival probability values of the SI items,

reliability values of the TF34 engine, the maximum operating times of SI items, and three different cost of repair values for the SI items that reflect whether or not the engine is already broken out for repair or if the SI item has failed before its maximum operating time.

5. The data analysis with the TF34 five year data base was accomplished efficiently due to the fact the data was readable by desktop software programs. The author of this thesis made attempts to investigate the five year data base further by making cost data queries via Logistics Management Decision Support System (LMDSS). Currently, Naval Postgraduate School (NPS) does not have the computing facilities to interface with LMDSS efficiently, consequently, a detailed cost data is still difficult to acquire. The author made contact with the Naval Aviation Maintenance Office (NAMO) to hopefully gain the computing facilities, however, this effort must be approached from higher management levels at the Naval Postgraduate School.

C. RECOMMENDATIONS

The following recommendations are offered as a result of the research performed in this thesis:

1. Focus attention on maintenance policy and procedures that will reduce the number of cannibalization maintenance actions and low failure times. The large number of zero FHSR engine records in the TF34 data base justify this action. Cannibalization actions represented the largest population of engine removals for the five year data base. A method for reducing cannibalizations may be to increase their visibility. For example, if a squadron has a readiness rate of 80%, which is above the Chief of Naval Operation's (CNO) goal for this particular aircraft, an engine cannibalization should not take place.

2. Broaden scope and depth of repair at the MIA level. The analysis in thesis demonstrated that as the number of successive repair actions MTBF decreased. A more in-depth and possible tighter inspection criteria may be a viable action to increase TF34 engine reliability.

3. Use test data on some selected SI items to compute their conditional survival probability (Non-Parametrically) and then compute their no-build times using equation (7) of this thesis. Then compare it with the no-build times currently in use. The ratio of costs, C_I/C_N, will be required to do this. If this ratio is not known, use equation (7) to determine what this ratio would have to be to arrive at the no-build times currently being used. Then ask if this derived ratio of cost is realistic. This is a topic for future study.

4. Methods and procedures for analyzing engine failures and removals can be accomplished using desktop software packages. All analysis in this thesis was accomplished with Microsoft Excel. These desktop software packages and programs should be made available where they could be useful.

5. Continue research into the problem of engine assembly to optimize the combination of life limited components that make up an engine at the IMA's and Depots. This is an extremely complex problem and it is generally managed without sophisticated decision support systems.

6. Install a LMDSS work station at the Naval Postgraduate School. This work station will allow real time data queries into the NALDA data base.

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APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0201021	3359	33	9572	2474	7K	S3B	3Q	8910
* 0201022	3076	301	9646	2474	3Q	S3A	2N	8910
* 0201127	4231	0	9298	2174	3W	S3A	7C	8910
* 0202032	4485	1239	65885	3372	7D		7C	8910
* 0202034	2929	155	9629	2474	5W	S3B	7C	8910
* 0202036	6133	1066	9192	2474	3Q	S3A	7C	8910
* 0202045	2885	485	9572	2474	6J	S3B	1Z	8910
* 0202060	4917	460	52947	2474	6M	US3A	5D	8910
* 0202072	3636	1638	9192	2474	5Q	S3A	1Z	8910
* 0202076	3632	0	3369	2475	7C		3Q	8910
* 0202092	3247	1633	9539	2474	7C	S3B	5G	8910
* 0202108	4171	267	9572	2174	3W	S3B	7D	8910
* 0202112	3728	79	63282	2474	4D	S3A	4P	8910
* 0202157	3206	137	9226	2474	7C	S3B	7C	8910
* 0202182	5234	3	65885	2374	4D	S3A	7D	8910
* 0202182	5234	3	65885	3372	7C		7D	8910
* 0202229	3871	399	9739	2474	5Q	S3A	3Q	8910
* 0202274	2888	731	9192	2174	3W	S3A	7L	8910
* 0202294	3863	988	9539	2474	5Q	S3B	7C	8910
* 0202336	4776	179	9572	2474	8F	S3B	5Q	8910
* 0202355	4322	1298	65885	2374	4D	S3A	3B	8910
* 0202356	4456	581	9381	2474	3Q	S3A	7C	8910
* 0202357	2146	31	9226	2174	3W	S3A	7C	8910
* 0202368	3690	176	9192	2474	5C	S3A	7C	8910
* 0202374	2820	0	3367	2475	3W		3Q	8910
* 0202377	3519	427	9226	2174	3W	S3A	7C	8910
* 0202386	4520	126	9204	2474	1Z	S3A	1Z	8910
* 0202394	2317	673	9226	2174	3W	S3B	7C	8910
* 0202410	4266	979	9572	2174	3W	S3B	3Q	8910
* 0202419	1873	686	9739	2474	1W	S3A	7C	8910
* 0202420	4405	226	9572	2474	7K	S3B	5C	8910
* 0202422	3683	624	9353	2474	7C	S3A	4D	8910
* 0202426	4468	889	9226	2474	7C	S3B	5Q	8910
* 0201124	1421	20	9204	2174	3W	S3A	3Q	8911
* 0202008	3165	242	9629	2174	3W	S3A	3U	8911
* 0202049	5184	1318	65885	2374	4D	S3A	1Z	8911
* 0202063	3016	722	421	2474	5D	S3A	8F	8911
* 0202080	5481	3	9629	2474	3P	S3A	7C	8911
* 0202091	3890	1099	9204	2174	3W	S3A	7E	8911
* 0202127	5584	291	9263	2474	1Z	S3A	5G	8911
* 0202136	4533	170	9539	2174	3W	S3A	7C	8911
* 0202164	4930	250	9629	2174	3W	S3A	7C	8911
* 0202169	4511	0	9353	2474	5Q	S3A	5Q	8911
* 0202170	2741	1113	9263	2474	7D	S3A	3Q	8911
* 0202192	4872	1635	9226	2174	3W	S3B	5C	8911
* 0202237	4404	0	9298	2174	3W	S3A	7C	8911
* 0202259	3098	304	9298	2474	1Z	S3A	1Z	8911
* 0202262	5036	696	9646	2474	3Q	S3A	3P	8911
* 0202286	1868	0	9353	2474	7K	S3A	1Z	8911
* 0202293	4420	224	9353	2174	3W	S3A	8F	8911

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202304	3285	271	9353	2174	3W	S3A	7C	8911
* 0202310	4249	1205	9539	2174	3W	S3A	1W	8911
* 0202324	3986	860	9629	2474	5C	S3B	8F	8911
* 0202338	3678	716	9192	2474	7C	S3A	3D	8911
* 0202360	3304	145	9353	2174	3W	S3A	1Z	8911
* 0202370	4750	263	9739	2474	6F	S3A	3R	8911
* 0202379	3410	1223	9539	2174	3W	S3A	3Q	8911
* 0202393	4800	667	52947	2474	1Z	US3A	7L	8911
* 0202401	4167	305	65885	3372	3A		7D	8911
* 0202403	4299	1165	9539	2474	3T	S3B	7D	8911
* 0202417	4806	1164	65885	3372	3A		7C	8911
* 0202422	3689	630	9353	2474	7C	S3A	4D	8911
* 0202441	4799	0	9192	2474	5Q	S3A	5G	8911
* 0202444	4619	846	65885	2374	4D	S3A	3D	8911
* 0202444	4619	846	65885	3372	7D		3D	8911
* 0201116	4486	914	9572	2474	7C	S3B	2N	8912
* 0201128	1942	9	9629	2174	3W	S3A	3Q	8912
* 0201128	1945	12	9629	2174	3W	S3A	3Q	8912
* 0202005	4762	615	9381	2474	1Z	S3A	3Q	8912
* 0202009	4697	352	9539	2174	3W	S3B	5C	8912
* 0202012	4390	243	9263	2174	3W	S3A	1Z	8912
* 0202018	4135	229	9204	2474	1Z	S3A	3R	8912
* 0202026	5538	516	9629	2474	1Z	S3A	5C	8912
* 0202053	5001	740	9629	2474	7C	S3B	7C	8912
* 0202064	5122	809	9204	2474	7A	S3A	5C	8912
* 0202067	1676	11	9629	2174	3W	S3A	5C	8912
* 0202080	5483	2	9629	2474	3P	S3A	3M	8912
* 0202084	4981	0	9298	2174	3W	S3A	5Q	8912
* 0202101	4322	848	9263	2174	3W	S3A	3Q	8912
* 0202106	2335	923	9353	2174	3W	S3A	1G	8912
* 0202112	3728	0	9298	2174	3W	S3A	3T	8912
* 0202120	2920	660	60200	3172	5C		7C	8912
* 0202125	5802	704	52947	2474	7L	US3A	1Z	8912
* 0202130	4758	200	9572	2174	3W	S3B	3T	8912
* 0202154	4694	1073	9629	2174	3W	S3A	2C	8912
* 0202158	5234	202	9646	2474	3Q	S3A	5C	8912
* 0202171	4147	327	9539	2174	3W	S3A	7K	8912
* 0202176	4008	11	9298	2474	2N	S3A	1Z	8912
* 0202237	4470	66	9298	2474	2S	S3A	7C	8912
* 0202245	4226	0	9353	2474	2S	S3A	7C	8912
* 0202276	4478	764	9287	2474	7C	S3B	5W	8912
* 0202281	4920	1547	9539	2174	3W	S3B	5Q	8912
* 0202282	5246	2	9646	2474	4P	S3A	3R	8912
* 0202310	4249	1205	9539	2174	3W	S3A	1W	8912
* 0202312	3249	719	9572	2474	7C	S3B	3R	8912
* 0202313	3100	139	9539	2174	3W	S3B	3Q	8912
* 0202317	3723	518	9287	2174	4D	S3B	1Z	8912
* 0202319	4814	112	9298	2174	3W	S3A	1Z	8912
* 0202326	4399	444	9263	2174	3W	S3A	7K	8912
* 0202348	4513	54	9263	2174	3W	S3A	5D	8912

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202388	3562	76	9192	2174	3W	S3A	2N	8912
* 0202391	3158	283	9572	2474	7C	S3B	7C	8912
* 0202397	1931	356	9539	2474	7C	S3A	7K	8912
* 0202400	4158	1611	9539	2474	7C	S3B	1W	8912
* 0202428	3009	52	9629	2174	3W	S3B	3Q	8912
* 0202431	3508	694	9192	2474	7C	S3A	7C	8912
* 0201118	5056	67	9739	2474	6F	S3A	7D	9001
* 0202009	4788	443	9539	2174	4D	S3B	5C	9001
* 0202011	3589	421	9539	2174	4D	S3A	7C	9001
* 0202015	3893	859	9629	2174	3W	S3A	5C	9001
* 0202040	4045	385	9204	2174	3W	S3A	5Q	9001
* 0202046	4773	798	52947	2474	7C	US3A	1W	9001
* 0202054	3314	656	9739	2474	5C	S3A	5B	9001
* 0202064	5122	0	246	2475	7A		7A	9001
* 0202091	3894	1103	65885	3372	7D		7E	9001
* 0202097	3421	700	9204	2174	3W	S3A	7C	9001
* 0202102	4724	918	9192	2174	3W	S3A	5C	9001
* 0202145	3314	178	9629	2174	3W	S3B	5C	9001
* 0202156	5689	958	9353	2174	4D	S3A	5C	9001
* 0202162	6255	1607	9381	2474	3W	S3A	7C	9001
* 0202174	5451	814	9192	2174	3W	S3A	7C	9001
* 0202178	4656	464	9381	2174	5G	S3A	4D	9001
* 0202185	3979	0	3367	2475	2A		3Q	9001
* 0202202	5002	1421	65885	2374	4D	US3A	2A	9001
* 0202206	3892	57	52947	2474	3P	US3A	3P	9001
* 0202211	3413	62	9353	2474	3U	S3A	8F	9001
* 0202217	4959	335	9381	2474	3W	S3A	7J	9001
* 0202220	2913	315	9287	2474	1Z	S3B	1Z	9001
* 0202223	6509	0	3365	2475	6J		3T	9001
* 0202235	4357	144	65885	2374	4D	US3A	3R	9001
* 0202261	4839	250	9353	2174	4D	S3A	3Q	9001
* 0202267	5742	385	9646	2474	3Q	S3A	4M	9001
* 0202272	3895	0	3359	2475	3Q		7C	9001
* 0202278	5393	914	9539	2174	3W	S3A	7C	9001
* 0202301	2035	787	65885	3372	7D		3Q	9001
* 0202306	3383	113	9629	2474	1Z	S3B	1Z	9001
* 0202307	4483	1209	9539	2474	7C	S3B	7E	9001
* 0202328	2225	394	52947	2474	3R	US3A	7C	9001
* 0202338	3678	0	9381	2475	7K		7C	9001
* 0202360	3352	193	9353	2174	3W	S3A	1Z	9001
* 0202360	3352	193	9353	2474	1G	S3A	1Z	9001
* 0202361	3295	484	9353	2474	1W	S3A	7C	9001
* 0202377	3701	609	9226	2474	3Q	S3B	7C	9001
* 0202416	2853	20	9381	2174	5G	S3A	3Q	9001
* 0202419	1921	48	52947	2474	1W	US3A	1W	9001
* 0202421	3971	525	9192	2174	3W	S3A	7D	9001
* 0202439	4403	811	9298	2474	3Q	S3A	6O	9001
* 0201101	4805	685	9739	2474	4P	S3A	5G	9002
* 0201109	3606	211	9298	2474	5C	S3A	5G	9002
* 0201116	4486	0	21297	2475	3W		7C	9002

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0201125	4018	92	9572	2174	3W	S3B	3Q	9002
* 0202024	3979	508	9204	2474	1W	S3A	7C	9002
* 0202037	4957	2	9739	2474	6F	S3A	7K	9002
* 0202049	5186	1320	65885	2374	4D	S3A	1Z	9002
* 0202049	5186	1320	65885	3372	5Q		1Z	9002
* 0202058	5065	320	9192	2474	4R	S3A	7D	9002
* 0202062	4464	40	9353	2474	1W	S3A	7C	9002
* 0202068	4261	1422	9539	2174	3W	S3B	7C	9002
* 0202070	4098	1823	9353	2474	7D	S3A	4R	9002
* 0202076	3715	83	9572	2474	2N	S3B	7C	9002
* 0202081	4545	187	9298	2174	3W	S3A	4P	9002
* 0202101	4326	852	65885	3372	3A		3Q	9002
* 0202106	2337	925	9353	2174	3W	S3A	1G	9002
* 0202106	2374	962	9353	2474	7C	S3A	1G	9002
* 0202107	1273	74	63282	2374	4D	S3A		9002
* 0202108	4333	429	9572	2174	3W	S3B	7D	9002
* 0202121	5454	1070	9572	2174	3W	S3B	6F	9002
* 0202121	5454	1070	9353	2174	4D	S3A	6F	9002
* 0202132	4347	327	9629	2174	3W	S3A	2N	9002
* 0202154	4747	1126	9539	2474	7C	S3A	2C	9002
* 0202171	4182	362	65885	2374	4D	S3B	7K	9002
* 0202171	4182	362	65885	3372	3A		7K	9002
* 0202228	4951	0	20993	2475	3W		5G	9002
* 0202241	4267	1114	9263	2474	7C	S3A	4D	9002
* 0202257	4967	552	9539	2474	7C	S3B	3B	9002
* 0202261	4839	250	9539	2174	3W	S3A	3Q	9002
* 0202271	5771	0	3364	2475	3W		7C	9002
* 0202278	5425	946	9572	2474	2N	S3B	7C	9002
* 0202281	4928	1555	65885	3372	3A		5Q	9002
* 0202291	4002	672	9629	2174	3W	S3A	7C	9002
* 0202299	5315	483	9739	2474	6F	S3A	5G	9002
* 0202307	4486	3	9572	2174	3W	S3B	7C	9002
* 0202314	2674	198	9192	2174	3W	S3A	7L	9002
* 0202317	3723	518	9629	2174	3W	S3B	1Z	9002
* 0202326	4403	448	65885	3372	3A		7K	9002
* 0202385	4054	1322	9192	2474	7C	S3A	3R	9002
* 0202390	4825	347	9646	2474	7A	S3A	7C	9002
* 0202392	2619	55	63282	2374	4D	S3A	1Z	9002
* 0202410	4454	1167	9572	2174	3W	S3B	3Q	9002
* 0202420	4459	54	9539	2174	3W	S3A	3Q	9002
* 0202421	3974	528	65885	2374	4D	S3A	7D	9002
* 0201102	5148	310	9539	2474	4M	S3B	5G	9003
* 0201113	5162	111	9353	2174	3W	S3A	3Q	9003
* 0201120	4930	1744	9192	2174	3W	S3A	7C	9003
* 0201124	1582	181	9263	2174	3W	S3A	3Q	9003
* 0201127	4525	294	9539	2474	4M	S3B	7C	9003
* 0202004	5082	0	9192	2174	3W	S3A	7C	9003
* 0202012	4532	385	9263	2474	6E	S3A	1Z	9003
* 0202027	4412	1441	9192	2474	3T	S3A	7K	9003
* 0202033	4307	1183	9287	2474	3A	S3B	8F	9003

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202045	2929	44	9572	2474	3R	S3B	5C	9003
* 0202051	3451	326	9381	2174	3W	S3A	2N	9003
* 0202052	3911	611	9192	2474	7C	S3A	3B	9003
* 0202056	2497	560	9381	2474	7C	S3A	8C	9003
* 0202068	4261	1422	9539	2174	3W	S3A	7C	9003
* 0202086	2080	116	9629	2474	3Q	S3B	3R	9003
* 0202102	4727	921	65885	3372	3A		5C	9003
* 0202107	1273	74	246	2475	3R			9003
* 0202118	4807	1603	9539	2474	7C	S3B	3A	9003
* 0202131	4540	404	9226	2474	3Q	S3B	7C	9003
* 0202137	4753	916	9739	2474	1Z	S3A	4D	9003
* 0202149	4595	485	9539	2474	3A	S3B	7C	9003
* 0202151	4353	467	9192	2474	5D	S3A	3P	9003
* 0202162	6255	0	9192	2174	3W	S3A	7C	9003
* 0202166	3428	191	9539	2174	3W	S3A	7C	9003
* 0202166	3439	202	9539	2174	3W	S3A	7C	9003
* 0202172	4481	735	9539	2474	7C	S3A	1G	9003
* 0202199	5800	753	9539	2174	3W	S3B	1Z	9003
* 0202208	4624	688	9381	2174	3W	S3A	5B	9003
* 0202208	4624	688	9381	2474	6Q	S3A	5B	9003
* 0202232	5360	1462	9298	2174	3W	S3A	1Z	9003
* 0202233	5394	1370	9381	2474	1W	S3A	3Q	9003
* 0202238	4702	555	9646	2474	7C	S3A	1Z	9003
* 0202256	4525	1102	9381	2174	3W	S3A	5C	9003
* 0202271	5791	20	9263	2474	5C	S3A	3W	9003
* 0202313	3252	291	9539	2174	3W	S3A	3Q	9003
* 0202315	3740	1074	9287	2474	7C	S3B	7C	9003
* 0202317	3800	595	9629	2474	7C	S3B	1Z	9003
* 0202319	4970	268	9298	2474	1Z	S3A	1Z	9003
* 0202327	4909	297	52947	2174	3W	US3A	3D	9003
* 0202331	3163	421	65885	3372	3A		5D	9003
* 0202348	4555	96	9263	2474	7K	S3A	5D	9003
* 0202373	3958	333	9226	2474	1G	S3B	7C	9003
* 0202381	2836	52	9192	2174	3W	S3A	7K	9003
* 0202383	4488	704	52947	2474	1Z	US3A	7L	9003
* 0202392	2619	55	246	2475	3R		1Z	9003
* 0202399	3930	291	52947	2474	6N	US3A	6F	9003
* 0202402	5019	2120	9353	2174	3W	S3A	3Q	9003
* 0202402	5027	2128	9353	2474	1Z	S3A	3Q	9003
* 0202404	4700	145	9539	2174	3W	S3A	7C	9003
* 0202410	4463	1176	65885	3372	3A		3Q	9003
* 0202412	4554	1551	9539	2174	3W	S3A	7K	9003
* 0202428	3059	102	9629	2174	3W	S3B	3Q	9003
* 0202440	4588	116	9204	2474	4P	S3A	6Q	9003
* 0201104	5166	293	65885	3372	3A		1Z	9004
* 0201120	5026	1840	9192	2474	7D	S3A	7C	9004
* 0202007	1778	616	9287	2174	4D	S3B	3R	9004
* 0202007	1778	616	9646	2475	7C		3R	9004
* 0202010	4107	415	9226	2474	1G	S3B	5C	9004
* 0202121	5516	1132	65885	3372	7C		6F	9004

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202136	4644	281	9539	2174	3W	S3A	7C	9004
* 0202162	6314	59	9192	2174	3W	S3A	7C	9004
* 0202164	5017	337	65885	3372	3A		7C	9004
* 0202166	3491	254	9539	2174	3W	S3A	7C	9004
* 0202217	4959	0	9192	2174	3W	S3A	7C	9004
* 0202271	5791	20	9263	2474	5C	S3A	3W	9004
* 0202283	3239	91	9539	2174	3W	S3A	7C	9004
* 0202307	4593	110	9353	2174	3W	S3A	7C	9004
* 0202311	3752	27	9263	2474	5C	S3A	3R	9004
* 0202334	5165	1178	9353	2174	3W	S3A	5C	9004
* 0202341	5337	845	9263	2174	3W	S3A	7D	9004
* 0202355	4490	1466	9298	2474	7C	S3A	3B	9004
* 0202356	4658	202	9204	2474	1G	S3A	5D	9004
* 0202363	4001	888	9226	2474	1Z	S3B	5C	9004
* 0202412	4576	1573	9539	2174	3W	S3A	7K	9004
* 0202428	3119	162	9629	2474	3Q	S3B	3Q	9004
* 0202438	4406	407	9646	2174	3W	S3A	5C	9004
* 0201113	5281	230	9353	2174	3W	S3A	3Q	9005
* 0201120	5041	15	9263	2474	6N	S3A	7D	9005
* 0201124	1610	209	9263	2174	3W	S3A	3Q	9005
* 0202002	4362	402	9739	2174	3W	S3A	6P	9005
* 0202020	4116	959	9263	2174	3W	S3A	8C	9005
* 0202025	4844	569	9298	2174	3W	S3A	1Z	9005
* 0202030	3567	688	9263	2474	1Z	S3A	2N	9005
* 0202035	2618	816	9381	2474	7C	S3A	1Z	9005
* 0202040	4173	513	9263	2474	7C	S3A	5Q	9005
* 0202043	5036	589	9381	2174	4D	S3A	3D	9005
* 0202051	3599	474	9381	2174	4D	S3A	2N	9005
* 0202068	4447	1608	9539	2474	7C	S3B	7C	9005
* 0202069	5017	404	65885	2374	4D	US3A	7L	9005
* 0202071	3765	339	9192	2174	3W	S3A	7L	9005
* 0202071	3765	339	9192	2474	7D	S3A	7L	9005
* 0202074	3558	199	9646	2474	2N	S3A	3W	9005
* 0202081	4631	273	9298	2174	3W	S3A	4P	9005
* 0202085	4858	82	9298	2474	1W	S3A	7D	9005
* 0202098	4123	210	9298	2174	4D	S3A	5Q	9005
* 0202140	2561	390	9739	2174	3W	S3A	7C	9005
* 0202160	4217	691	421	2474	7C	S3B	5Q	9005
* 0202161	4515	653	9287	2474	1Z	S3B	3W	9005
* 0202167	3517	432	9739	2174	3W	S3A	5Q	9005
* 0202180	5317	821	9298	2474	5G	S3A	7C	9005
* 0202182	5430	196	9353	2174	3W	S3A	7C	9005
* 0202186	4357	381	52947	2474	2N	US3A	1Z	9005
* 0202201	4643	1482	9353	2474	5Q	S3B	6A	9005
* 0202206	3923	31	65885	2374	4D	US3A	3P	9005
* 0202208	4624	0	9192	2174	3W	S3A	6Q	9005
* 0202209	4521	401	52947	2474	6P	US3A	7C	9005
* 0202219	4495	426	9739	2174	3W	S3A	5G	9005
* 0202223	6626	117	52947	2474	3R	US3A	6Y	9005
* 0202226	3405	361	65885	3372	3A		3W	9005

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202247	3621	879	9646	2474	3Q	S3A	7C	9005
* 0202253	5297	402	9739	2174	3W	S3A	3M	9005
* 0202278	5470	45	9629	2474	3Q	S3B	2N	9005
* 0202291	4146	816	9572	2474	3R	S3B	7C	9005
* 0202317	3808	8	9263	2174	3W	S3A	7C	9005
* 0202323	4442	196	9353	2174	3W	S3A	8C	9005
* 0202339	4272	738	9226	2474	7C	S3B	3Q	9005
* 0202342	2825	42	52947	2474	6T	US3A	7E	9005
* 0202353	4479	691	421	2474	7C	S3B	5C	9005
* 0202354	4880	1447	9739	2174	3W	S3A	6F	9005
* 0202355	4491	1	9298	2474	3Q	S3A	7C	9005
* 0202367	4118	46	52947	2474	8C	US3A	1Z	9005
* 0202380	4716	953	9263	2474	1Z	S3A	5D	9005
* 0202416	3059	226	9381	2174	4D	S3A	3Q	9005
* 0202423	4079	1246	9646	2174	3W	S3A	6Q	9005
* 0201113	5313	262	9353	2474	1Z	S3B	3Q	9006
* 0201128	2233	300	9629	2174	3W	S3B	3Q	9006
* 0202022	4387	40	9739	2474	3T	S3A	7D	9006
* 0202035	2619	1	9192	2174	3W	S3A	7C	9006
* 0202054	3349	35	52947	2474	6F	US3A	5C	9006
* 0202083	3548	405	9204	2474	2C	S3A	7J	9006
* 0202086	2096	16	9539	2174	3W	S3A	2S	9006
* 0202095	5605	428	9192	2474	7D	S3A	3T	9006
* 0202128	4239	421	9646	2174	3W	S3A	5C	9006
* 0202141	4315	988	9646	2474	7C	S3A	3T	9006
* 0202162	6342	87	9192	2174	3W	S3A	7C	9006
* 0202163	2813	356	9381	2174	4D	S3A	7C	9006
* 0202169	4511	0	421	2174	3W	S3B	5Q	9006
* 0202207	5319	434	9539	2474	1Z	S3B	5Q	9006
* 0202241	4310	43	9298	2174	4D	S3A	7C	9006
* 0202253	5298	403	9739	2174	3W	S3A	3M	9006
* 0202263	5172	416	9192	2174	3W	S3A	3Q	9006
* 0202266	3218	882	421	2474	3P	S3A	4J	9006
* 0202269	3596	16	9539	2174	3W	S3A	7C	9006
* 0202273	4610	823	9298	2174	4D	S3A	3W	9006
* 0202283	3275	127	9539	2174	3W	S3A	7C	9006
* 0202293	4634	438	9353	2474	1Z	S3A	8F	9006
* 0202297	4698	927	9381	2174	4D	S3A	1Z	9006
* 0202297	4698	927	9298	2474	5G	S3A	1Z	9006
* 0202302	5082	211	9381	2474	1G	S3A	5C	9006
* 0202304	3304	290	9353	2474	1Z	S3B	7C	9006
* 0202314	2910	434	9192	2174	3W	S3A	7L	9006
* 0202360	3546	387	9572	2474	3P	S3B	1Z	9006
* 0202378	4138	230	9298	2474	3Q	S3A	5Q	9006
* 0202379	3804	1617	9539	2474	1C	S3B	3Q	9006
* 0202384	4146	734	9646	2174	3W	S3A	1Z	9006
* 0202386	4539	19	9263	2474	2A	S3A	1Z	9006
* 0202394	2496	852	9353	2474	7C	S3A	7C	9006
* 0202401	4199	32	9353	2174	3W	S3A	3A	9006
* 0202412	4594	1591	9353	2174	3W	S3A	7K	9006

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202417	4837	31	9353	2174	3W	S3A	3A	9006
* 0201112	5189	927	9572	2474	3P	S3B	5G	9007
* 0201123	4543	854	9263	2474	7C	S3A	2N	9007
* 0202009	4854	509	55600	2474	7C	S3A	5C	9007
* 0202031	5534	791	9298	2474	6F	S3A	6Q	9007
* 0202047	3116	1219	65885	2374	4D	S3A	5W	9007
* 0202055	5376	592	52947	2474	7L	US3A	6F	9007
* 0202089	4435	226	9298	2174	3W	S3A	5C	9007
* 0202089	4435	226	9298	2474	7A	S3A	5C	9007
* 0202103	2347	1363	65885	2374	4D	S3A		9007
* 0202128	4243	425	9646	2174	3W	S3A	5C	9007
* 0202139	4658	404	9539	2474	5Q	S3B	3Q	9007
* 0202192	5056	1819	9646	2174	3W	S3A	5C	9007
* 0202202	5036	1455	52947	2474	7C	US3A	2A	9007
* 0202203	3448	679	9539	2474	1Z	S3B	3Q	9007
* 0202233	5394	0	9298	2174	3W	S3A	3T	9007
* 0202236	5822	1360	9226	2174	4D	S3B	7D	9007
* 0202261	5025	436	9539	2474	2S	S3B	3Q	9007
* 0202293	4634	0	9646	2174	3W	S3A	1Z	9007
* 0202307	4686	203	9353	2474	7C	S3A	7C	9007
* 0202322	4028	117	9226	2174	4D	S3B	7C	9007
* 0202363	4005	4	9646	2174	3W	S3A	1Z	9007
* 0202366	4428	56	9298	2474	2C	S3A	5D	9007
* 0202380	4746	30	9298	2174	3W	S3A	1Z	9007
* 0202400	4288	130	9226	2174	4D	S3B	6P	9007
* 0202412	4603	1600	9646	2174	3W	S3A	7K	9007
* 0202413	4508	336	9572	2474	7C	S3B	2C	9007
* 0201022	3100	24	9646	2174	3W	S3A	3Q	9008
* 0201022	3115	39	9646	2474	8P	S3A	3Q	9008
* 0201118	5094	0	68539	2475	4A		6F	9008
* 0202008	3454	531	9629	2474	7C	S3B	3U	9008
* 0202011	3648	480	55600	2174	3W	S3A	7C	9008
* 0202034	2929	0	21247	2475	6A		5C	9008
* 0202038	3546	922	9298	2174	3W	S3A	7D	9008
* 0202049	5196	10	9539	2174	3W	S3A	5Q	9008
* 0202049	5196	10	9539	2474	8P	S3A	5Q	9008
* 0202051	3605	480	65885	2374	4D	S3A	2N	9008
* 0202063	3130	114	9353	2174	3W	S3A	3B	9008
* 0202063	3130	114	9353	2174	3W	S3A	3B	9008
* 0202063	3131	115	9353	2174	3W	S3B	3B	9008
* 0202063	3131	115	9353	2474	7K	S3A	3B	9008
* 0202071	3777	12	9298	2174	3W	S3A	7C	9008
* 0202076	3834	119	9629	2174	3W	S3B	3Q	9008
* 0202081	4727	369	9298	2174	3W	S3A	4P	9008
* 0202086	2102	22	9539	2174	3W	S3A	2S	9008
* 0202086	2102	22	9539	2174	3W	S3A	2S	9008
* 0202089	4442	7	9298	2174	3W	S3A	7J	9008
* 0202089	4442	7	9298	2474	7J	S3A	7J	9008
* 0202090	3061	0	9646	2174	3W	S3A	7C	9008
* 0202095	5650	45	9298	2174	3W	S3A	7C	9008

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202095	5651	46	9298	2174	3W	S3A	7C	9008
* 0202098	4246	333	9381	2474	7K	S3A	5Q	9008
* 0202113	4165	382	9263	2474	1Z	S3A	5Q	9008
* 0202120	2985	65	9539	2174	4D	S3B	5C	9008
* 0202120	2994	74	9629	2474	8P	S3B	5C	9008
* 0202127	5830	246	9629	2474	1Z	S3B	1Z	9008
* 0202128	4243	425	9646	2174	3W	S3A	5C	9008
* 0202128	4243	425	9646	2174	3W	S3A	5C	9008
* 0202155	4072	143	9572	2474	1Z	S3B	7C	9008
* 0202172	4546	65	9539	2174	4D	S3B	7C	9008
* 0202193	4035	1497	55600	2474	7D	S3B	2N	9008
* 0202197	4967	506	9629	2174	3W	S3B	7K	9008
* 0202198	5228	0	246	2475	6A		1Z	9008
* 0202208	4649	25	9192	2174	3W	S3A	6Q	9008
* 0202212	5063	576	9629	2474	7C	S3B	7C	9008
* 0202213	5521	1316	9353	2474	6F	S3B	1Z	9008
* 0202232	5412	1514	65885	2374	4D	S3A	1Z	9008
* 0202233	5439	45	9298	2474	5D	S3A	3T	9008
* 0202236	5812	1350	9539	2474	7J	S3B	7D	9008
* 0202252	3466	579	9646	2174	3W	S3B	7K	9008
* 0202269	3602	22	9539	2174	3W	S3A	7C	9008
* 0202269	3602	22	9539	2174	3W	S3A	7C	9008
* 0202274	3283	1126	9192	2174	3W	S3A	7L	9008
* 0202279	4656	587	9298	2474	5G	S3A	7D	9008
* 0202281	4929	1	9353	2174	4D	S3A	3A	9008
* 0202281	4939	11	9629	2474	8P	S3B	3A	9008
* 0202293	4668	34	9646	2174	3W	S3A	1Z	9008
* 0202298	3903	197	9629	2174	3W	S3B	2N	9008
* 0202313	3634	673	9539	2174	4D	S3B	3Q	9008
* 0202331	3163	0	65885	2374	4A	S3B	3A	9008
* 0202346	4314	19	9353	2474	5W	S3B	7C	9008
* 0202363	4053	52	9646	2174	3W	S3A	1Z	9008
* 0202377	3714	13	9539	2174	3W	S3A	3Q	9008
* 0202397	2146	215	9226	2474	3T	S3B	3Q	9008
* 0202423	4190	1357	9646	2174	3W	S3B	6Q	9008
* 0202437	4948	313	52947	2474	6F	US3A	5D	9008
* 0202443	4455	470	9646	2174	3W	S3A	5C	9008
* 0201106	5799	960	9204	2174	3W	S3A	5Q	9009
* 0202055	5387	11	52947	2474	1W	US3A	7L	9009
* 0202086	2147	67	9539	2474	3T	S3B	2S	9009
* 0202095	5651	46	9298	2174	3W	S3A	7C	9009
* 0202136	4681	318	9646	2174	3W	S3A	7C	9009
* 0202180	5340	23	9298	2174	3W	S3A	7C	9009
* 0202186	4357	0	62876	2475	7C		3D	9009
* 0202188	5474	1373	9298	2474	2N	S3A	5C	9009
* 0202192	5059	1822	9539	2174	3W	S3A	5C	9009
* 0202196	3590	420	9298	2174	3W	S3A	3D	9009
* 0202208	4649	25	9192	2474	3R	S3A	6Q	9009
* 0202224	5150	888	9204	2174	3W	S3A	3Q	9009
* 0202243	4747	981	9539	2174	3W	S3B	7C	9009

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202302	5082	0	3362	2475	3E		1G	9009
* 0202303	4229	1626	9287	2474	7C	S3B	5C	9009
* 0202322	4100	189	9353	2474	5Q	S3B	7C	9009
* 0202323	4638	392	9353	2474	8P	S3B	8C	9009
* 0202359	4736	355	52947	2474	8C	US3A	7D	9009
* 0202377	3714	13	9539	2174	3W	S3A	3Q	9009
* 0202381	2970	186	9192	2474	7D	S3A	7K	9009
* 0202402	5047	20	9646	2174	3W	S3A	3U	9009
* 0202402	5047	20	9646	2174	3W	S3A	3U	9009
* 0202412	4606	1603	9539	2174	3W	S3A	7K	9009
* 0202423	4200	1367	9539	2174	3W	S3B	6Q	9009
* 0202444	4656	37	9353	2474	1Z	S3B	7D	9009
* 0201106	5833	994	9204	2474	2N	S3A	5Q	9010
* 0201119	5189	536	9646	2174	3W	S3B	7C	9010
* 0201125	4496	570	9572	2474	7C	S3B	3Q	9010
* 0202014	3339	1029	9539	2174	3W	S3A	7E	9010
* 0202015	4350	1316	9629	2174	3W	S3B	5C	9010
* 0202020	4258	1101	9263	2474	7C	S3A	8C	9010
* 0202030	3846	279	9381	2474	1Z	S3A	1Z	9010
* 0202038	3566	942	9298	2474	1Z	S3A	7D	9010
* 0202043	5079	632	9263	2474	7C	S3A	3D	9010
* 0202060	4917	0	3361	2475	4D		5C	9010
* 0202075	2865	1006	9298	2474	5C	S3A	3T	9010
* 0202076	3834	119	9539	2474	7C	S3A	3Q	9010
* 0202088	4524	608	9646	2174	3W	S3A	1G	9010
* 0202096	2036	495	9287	2474	7C	S3B	5C	9010
* 0202106	2374	0	9287	2474	7J	S3B	7C	9010
* 0202108	4508	604	9353	2174	4D	S3B	7D	9010
* 0202122	4950	814	9539	2474	5Q	S3B	2N	9010
* 0202140	2564	393	65885	2374	4D	S3A	7C	9010
* 0202146	3518	892	9381	2474	5Q	S3A	2N	9010
* 0202260	5618	1175	9539	2474	8C	S3B	7C	9010
* 0202263	5242	486	9192	2474	7C	S3A	3Q	9010
* 0202276	4659	181	9572	2174	3W	S3B	7C	9010
* 0202300	3799	705	9572	2174	3W	S3B	2S	9010
* 0202305	4349	391	9287	2474	3Q	S3B	6F	9010
* 0202336	5140	364	9572	2474	7C	S3B	2N	9010
* 0202338	3987	309	9381	2474	8C	S3A	7K	9010
* 0202354	4883	1450	65885	2374	4D	S3A	6F	9010
* 0202369	4631	367	9646	2174	3W	S3A	3Q	9010
* 0202417	5052	246	9539	2174	3W	S3A	3A	9010
* 0201022	3155	79	9353	2174	3W	S3B	3Q	9011
* 0201108	4576	185	9298	2174	3W	S3A	2S	9011
* 0201121	2591	1101	9539	2174	3W	S3B	4M	9011
* 0201123	4723	180	9353	2174	3W	S3B	7C	9011
* 0202001	4095	366	9646	2174	3W	S3A	6F	9011
* 0202003	4538	822	9629	2474	1G	S3B	5C	9011
* 0202007	1892	114	9646	2174	3W	S3B	7C	9011
* 0202007	1892	114	9539	2174	4D	S3A	7C	9011
* 0202011	3690	522	55600	2474	5G	S3B	7C	9011

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202036	6665	532	9381	2474	7D	S3A	3Q	9011
* 0202060	4917	0	9192	2174	3W	S3A	6A	9011
* 0202087	4339	1285	9629	2174	4D	S3B	7K	9011
* 0202113	4249	84	9192	2174	3W	S3A	1Z	9011
* 0202121	5687	171	9646	2174	3W	S3B	7C	9011
* 0202126	5621	1546	9192	2174	3W	S3A	3T	9011
* 0202128	4364	546	9539	2174	3W	S3B	5C	9011
* 0202136	4733	370	9646	2474	7C	S3A	7C	9011
* 0202140	2564	393	65885	3372	3A		7C	9011
* 0202141	4328	13	9646	2174	3W	S3A	7C	9011
* 0202153	4666	1	9263	2174	3W	S3A	7C	9011
* 0202155	4072	0	9646	2174	3W	S3A	1Z	9011
* 0202163	3015	558	9298	2474	5G	S3A	7C	9011
* 0202167	3654	569	9263	2174	3W	S3A	5Q	9011
* 0202171	4352	170	9263	2174	3W	S3A	3A	9011
* 0202174	5921	1284	9192	2174	3W	S3A	7C	9011
* 0202174	5921	1284	9192	2174	3W	S3A	7C	9011
* 0202188	5484	10	9192	2174	3W	S3A	2N	9011
* 0202210	3581	457	9263	2174	3W	S3A	5G	9011
* 0202225	5875	2357	9353	2174	3W	S3B	7K	9011
* 0202229	4041	170	9204	2174	3W	S3A	5Q	9011
* 0202281	5004	65	9646	2174	3W	S3A	6A	9011
* 0202285	4423	271	9204	2174	3W	S3A	1Z	9011
* 0202293	4760	126	9646	2174	3W	S3A	1Z	9011
* 0202306	3756	373	9539	2174	3W	S3B	1Z	9011
* 0202309	4347	574	9646	2174	3W	S3B	5B	9011
* 0202315	4097	357	9353	2474	3T	S3B	7C	9011
* 0202322	4141	41	9353	2174	3W	S3B	5Q	9011
* 0202324	4443	457	9646	2174	3W	S3B	3Q	9011
* 0202330	5157	662	9192	2474	1Z	S3A	7C	9011
* 0202344	5154	663	9298	2174	3W	S3A	7C	9011
* 0202347	3610	492	9539	2474	2N	S3A	7C	9011
* 0202354	4883	1450	65885	3372	1Z		6F	9011
* 0202363	4145	144	9646	2174	3W	S3A	1Z	9011
* 0202368	4080	390	9263	2174	3W	S3A	5C	9011
* 0202369	4700	436	9646	2174	3W	S3B	3Q	9011
* 0202378	4138	0	9263	2174	3W	S3A	3Q	9011
* 0202384	4406	994	9646	2174	3W	S3B	1Z	9011
* 0202386	4551	12	9263	2174	3W	S3A	4B	9011
* 0202388	3845	359	65885	2374	4D	S3A	2N	9011
* 0202391	3328	170	9263	2174	3W	S3A	3Q	9011
* 0202395	4837	778	9192	2174	3W	S3A	7C	9011
* 0202398	4618	1496	9263	2174	3W	S3A	7C	9011
* 0202401	4577	410	9353	2174	4D	S3B	3A	9011
* 0202423	4232	1399	9539	2474	5C	S3B	6Q	9011
* 0202424	4003	520	9298	2174	3W	S3A	7C	9011
* 0202439	4552	149	65885	2374	4D	S3A	3Q	9011
* 0202444	4656	0	9646	2174	3W	S3A	1Z	9011
* 0201103	5428	1018	9287	2474	3D	S3B	1Z	9012
* 0201111	5268	919	9572	2474	7C	S3B	7C	9012

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0201116	4874	388	9646	2174	3W	S3B	3W	9012
* 0201120	5041	0	65885	2374	4D	S3B	4A	9012
* 0201124	1986	585	9263	2174	3W	S3A	3Q	9012
* 0202013	4997	526	9263	2174	3W	S3A	7C	9012
* 0202023	4757	770	9192	2474	3P	S3A	1Z	9012
* 0202040	4456	283	9263	2174	3W	S3A	7C	9012
* 0202047	3152	1255	9263	2174	3W	S3A	5W	9012
* 0202091	4062	168	9263	2474	1Z	S3A	7D	9012
* 0202103	2385	1401	9263	2174	3W	S3A		9012
* 0202109	3848	59	63282	3372	6A		2N	9012
* 0202145	3508	372	9629	2174	4D	S3B	5C	9012
* 0202166	3687	450	9353	2174	4D	S3B	7C	9012
* 0202169	4625	114	421	2474	1Z	S3A	5Q	9012
* 0202173	3010	1030	9539	2474	5Q	S3B	2C	9012
* 0202180	5384	67	65885	2374	4D	S3A	7C	9012
* 0202199	6253	1206	9539	2474	7C	S3B	1Z	9012
* 0202203	3495	47	9353	2174	4D	S3B	1Z	9012
* 0202203	3495	47	9539	2174	3W	S3B	1Z	9012
* 0202204	5260	804	9739	2474	5B	S3B	2S	9012
* 0202205	4933	914	65885	2374	4D	S3A	5G	9012
* 0202215	4209	749	9739	2174	3W	S3A	3T	9012
* 0202220	3029	116	9287	2474	3M	S3B	1Z	9012
* 0202224	5164	902	65885	2374	4D	S3A	3Q	9012
* 0202225	5876	2358	9739	2174	3W	S3B	7K	9012
* 0202225	5877	2359	9739	2174	3W	S3A	7K	9012
* 0202231	4847	1175	9539	2174	3W	S3A	7K	9012
* 0202234	3815	190	9192	2474	1Z	S3A	1Z	9012
* 0202237	4785	315	9204	2174	3W	S3A	2S	9012
* 0202239	4367	896	9739	2474	5W	S3A	5C	9012
* 0202250	4946	733	52947	2474	5Q	US3A	7C	9012
* 0202254	5772	1476	9204	2474	7C	S3A	5C	9012
* 0202293	4782	148	9539	2174	4D	S3A	1Z	9012
* 0202293	4788	154	9353	2474	1Z	S3B	1Z	9012
* 0202298	4166	460	9629	2174	3W	S3B	2N	9012
* 0202310	4501	1457	9629	2174	4D	S3B	1W	9012
* 0202324	4443	457	9539	2174	3W	S3A	3Q	9012
* 0202332	4780	542	9263	2174	3W	S3A	5G	9012
* 0202355	4775	284	9263	2174	3W	S3A	3Q	9012
* 0202363	4280	279	9646	2474	7K	S3B	1Z	9012
* 0202370	5368	618	52947	2474	3T	US3A	6F	9012
* 0202391	3328	170	9263	2174	3W	S3A	3Q	9012
* 0202406	3358	553	9353	2174	3W	S3B	5C	9012
* 0202407	5113	821	9539	2474	7C	S3B	7C	9012
* 0202420	4799	394	9572	2174	4D	S3B	3Q	9012
* 0202434	3357	141	63282	3372	6A		7C	9012
* 0202434	3357	141	63282	2374	4D	S3A	7C	9012
* 0202439	4552	149	65885	3372	1Z		3Q	9012
* 0201120	5041	0	65885	3372	6Q		4A	9101
* 0202025	5229	954	9298	2474	5C	S3A	1Z	9101
* 0202051	3605	480	65885	3372	3A		2N	9101

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202052	4450	539	9381	2174	3W	S3A	7C	9101
* 0202080	5843	360	9226	2474	7C	S3B	6P	9101
* 0202090	3437	376	9629	2474	1Z	S3B	7C	9101
* 0202095	5694	89	65885	2374	4D	S3A	7C	9101
* 0202095	5694	89	65885	3372	1Z		7C	9101
* 0202134	5203	1115	9226	2474	3Q	S3B	7K	9101
* 0202149	4595	0	3367	2475	3W		2S	9101
* 0202156	6360	1629	9539	2474	7C	S3B	5C	9101
* 0202183	5548	1354	9572	2174	4D	S3B	5C	9101
* 0202203	3495	47	9539	2474	5W	S3B	1Z	9101
* 0202205	4933	914	65885	3372	1Z		5G	9101
* 0202224	5164	902	65885	3372	1Z		3Q	9101
* 0202232	5412	1514	65885	3372	3A		1Z	9101
* 0202235	5045	832	52947	2474	2S	US3A	3R	9101
* 0202252	3592	705	9539	2174	3W	S3A	7K	9101
* 0202288	4124	847	421	2174	3W	S3B	5G	9101
* 0202300	3956	862	9572	2474	1Z	S3B	2S	9101
* 0202304	3436	132	65885	2374	4D	S3B	7C	9101
* 0202340	4595	227	52947	2474	5W	US3A	5C	9101
* 0202342	2827	2	52947	2474	7K	US3A	6T	9101
* 0202346	4315	1	9539	2474	5W	S3B	5W	9101
* 0202356	4791	133	9381	2174	3W	S3A	6Q	9101
* 0202359	4748	12	52947	2474	3T	US3A	5D	9101
* 0202412	4616	1613	65885	2374	4D	S3B	7K	9101
* 0202444	4660	4	9646	2474	1Z	S3B	1Z	9101
* 0201021	3840	481	9572	2174	4D	S3B	1Z	9102
* 0201104	5166	0	3361	2475	3W		3A	9102
* 0201111	5281	13	9572	2174	3W	S3B	7C	9102
* 0202002	4454	494	65885	2374	4D	S3A	6P	9102
* 0202009	4979	134	9539	2174	3W	S3B	7C	9102
* 0202025	5229	0	246	2475	3R		5D	9102
* 0202035	3213	595	9192	2474	3U	S3A	7C	9102
* 0202069	5071	458	52947	2174	3W	US3A	7L	9102
* 0202126	5637	1562	9204	2474	5G	S3A	3T	9102
* 0202127	5990	160	9629	2474	3Q	S3B	1Z	9102
* 0202128	4375	557	65885	2374	4D	S3B	5C	9102
* 0202130	5239	681	9572	2474	1Z	S3B	3T	9102
* 0202131	5131	591	9226	2474	7C	S3B	2S	9102
* 0202133	3777	560	65885	2374	4D	S3A	3R	9102
* 0202133	3777	560	65885	3372	1Z		3R	9102
* 0202141	4543	228	9646	2174	4D	S3B	7C	9102
* 0202142	5726	850	9646	2474	2N	S3B	8F	9102
* 0202161	4854	339	9646	2174	3W	S3B	1Z	9102
* 0202166	3759	522	9572	2474	7C	S3B	7C	9102
* 0202181	5997	1513	9539	2474	5Q	S3B	7C	9102
* 0202222	5709	383	9298	2174	3W	S3A	2F	9102
* 0202243	4873	1107	9539	2174	4D	S3A	7C	9102
* 0202269	3912	332	9539	2474	5Q	S3B	7C	9102
* 0202283	3718	570	9287	2474	2S	S3B	7C	9102
* 0202290	4214	422	9539	2474	3R	S3B	7D	9102

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202327	6096	1484	52947	2474	7C	US3A	3D	9102
* 0202358	4897	752	9287	2474	7C	S3B	7K	9102
* 0202376	5247	1278	9226	2474	7C	S3B	2N	9102
* 0202384	4428	1016	9539	2174	3W	S3A	1Z	9102
* 0202398	4720	1598	9298	2474	3R	S3A	7C	9102
* 0202404	5064	509	9629	2474	5B	S3B	7C	9102
* 0202412	4616	1613	65885	3372	3A		7K	9102
* 0202427	4540	345	9646	2474	2N	S3B	1Z	9102
* 0202437	5018	70	52947	2474	3R	US3A	6F	9102
* 0201021	3870	511	9539	2174	3W	S3B	1Z	9103
* 0201113	5335	22	9539	2474	2N	S3B	1Z	9103
* 0201116	5021	535	9539	2174	3W	S3B	3W	9103
* 0201123	4878	335	9539	2174	3W	S3B	7C	9103
* 0202015	4361	1327	65885	2374	4D	S3B	5C	9103
* 0202024	4711	732	52947	2474	7C	US3A	1W	9103
* 0202046	5930	1157	52947	2474	7C	US3A	7D	9103
* 0202054	3511	162	65885	2374	4D	US3A	6F	9103
* 0202060	5339	422	9192	2474	3R	S3A	6A	9103
* 0202063	3136	5	9629	2474	8C	S3B	7K	9103
* 0202068	4583	136	9539	2174	3W	S3A	7C	9103
* 0202087	4339	1285	9539	2474	5Q	S3A	7K	9103
* 0202091	4062	168	9298	2474	5C	S3A	7D	9103
* 0202101	4457	131	9353	2174	3W	S3B	3A	9103
* 0202118	4954	147	9629	2174	3W	S3B	7C	9103
* 0202128	4375	557	65885	3372	1Z		5C	9103
* 0202145	3514	378	9539	2174	3W	S3A	5C	9103
* 0202225	6032	2514	9539	2174	3W	S3B	7K	9103
* 0202227	5467	958	9629	2474	1Z	S3B	7H	9103
* 0202250	5015	69	52947	2474	5Q	US3A	5Q	9103
* 0202256	5042	1619	9192	2474	7C	S3A	5C	9103
* 0202296	5268	778	9287	2474	5B	S3B	4P	9103
* 0202298	4172	466	9539	2174	3W	S3A	2N	9103
* 0202306	3911	528	9539	2174	3W	S3A	1Z	9103
* 0202312	3465	216	9629	2474	6Q	S3B	7C	9103
* 0202340	4615	20	52947	2474	2P	US3A	5W	9103
* 0202344	5253	762	9298	2474	5G	S3A	7C	9103
* 0202419	2194	273	65885	2374	4D	US3A	1W	9103
* 0201121	2740	1250	9539	2174	3W	S3B	4M	9104
* 0201123	4930	387	9539	2174	3W	S3B	7C	9104
* 0202015	4361	1327	65885	3372	3A		5C	9104
* 0202016	5204	297	9204	2174	3W	S3A	3R	9104
* 0202020	4278	20	9204	2174	3W	S3A	7C	9104
* 0202049	5456	260	9539	2174	3W	S3B	6A	9104
* 0202062	5011	547	9539	2174	3W	S3B	2N	9104
* 0202065	2654	559	9572	2474	7C	S3B	5C	9104
* 0202096	2036	0	60200	2475	3B		7C	9104
* 0202097	4004	1283	9204	2174	3W	S3A	7C	9104
* 0202116	4513	478	9572	2474	7C	S3B	2N	9104
* 0202125	6036	234	9204	2174	3W	S3A	7L	9104
* 0202129	5267	1477	9204	2174	3W	S3A	3W	9104

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202174	5997	1360	9298	2474	5C	S3A	7C	9104
* 0202179	4100	836	9629	2474	7C	S3B	7C	9104
* 0202198	5265	37	65885	2374	4D	S3A	6A	9104
* 0202209	4521	0	9192	2474	3R	S3A	6P	9104
* 0202214	4983	11	9298	2174	3W	S3A	7D	9104
* 0202217	5282	323	9298	2474	6J	S3A	7C	9104
* 0202226	3455	50	9739	2174	3W	S3A	3A	9104
* 0202234	3815	0	21297	2475	3W		1Z	9104
* 0202242	4784	1606	9287	2474	7C	S3B	4D	9104
* 0202253	5564	669	9739	2174	3W	S3B	3M	9104
* 0202264	4124	78	9646	2474	3Q	S3B	3B	9104
* 0202266	3557	339	9629	2474	1G	S3B	3B	9104
* 0202278	5485	15	9629	2474	8F	S3B	3Q	9104
* 0202320	2853	979	9204	2174	3W	S3A	3D	9104
* 0202336	5155	15	9629	2474	3Q	S3B	7C	9104
* 0202364	5343	1084	9298	2474	6J	S3A	2N	9104
* 0202365	6022	745	9298	2474	6J	S3A	8C	9104
* 0202367	4201	83	52947	2474	1G	US3A	8C	9104
* 0202377	4178	477	9539	2474	3P	S3B	3Q	9104
* 0202381	2978	8	65885	2374	4D	S3A	7C	9104
* 0202383	4497	9	52947	2474	6F	US3A	1Z	9104
* 0202420	4899	494	9353	2474	6F	S3B	3Q	9104
* 0202432	4527	1379	9226	2474	3Q	S3B	5D	9104
* 0201102	5200	52	9739	2174	3W	S3A	4M	9105
* 0202024	4778	67	52947	2474	3D	US3A	7D	9105
* 0202052	4458	547	9381	2174	3W	S3A	7C	9105
* 0202053	5762	761	9287	2474	3Q	S3B	7C	9105
* 0202070	4387	289	9226	2474	7C	S3B	7C	9105
* 0202071	3941	176	9204	2174	3W	S3A	7C	9105
* 0202111	4476	247	9204	2174	3W	S3A	7C	9105
* 0202117	3939	1042	9226	2474	5Q	S3B	1W	9105
* 0202137	4848	115	65885	2374	4D	S3B	1Z	9105
* 0202137	4848	115	65885	3372	5W		1Z	9105
* 0202141	4557	242	9539	2474	6F	S3A	7C	9105
* 0202195	3888	511	9298	2474	7C	S3A	1Z	9105
* 0202202	5197	161	9381	2174	3W	S3A	7C	9105
* 0202219	4845	776	9739	2174	3W	S3B	5G	9105
* 0202231	4851	1179	65885	2374	4D	S3B	7K	9105
* 0202231	4851	1179	65885	3372	3A		7K	9105
* 0202233	5634	195	9204	2474	8C	S3A	3Q	9105
* 0202251	2492	1056	9226	2474	4B	S3B	2S	9105
* 0202287	3890	1162	9298	2474	7C	S3A	3Q	9105
* 0202289	4836	1072	9226	2474	4B	S3B	4P	9105
* 0202313	4347	1386	9629	2474	7C	S3B	3Q	9105
* 0202357	2673	558	9226	2474	7C	S3B	7C	9105
* 0202361	4074	779	9226	2174	3W	S3B	7K	9105
* 0202391	3575	417	9263	2474	4P	S3A	3Q	9105
* 0202401	4777	610	9572	2474	7C	S3B	3A	9105
* 0202416	3534	701	9381	2174	3W	S3A	3Q	9105
* 0202431	3949	441	9739	2474	1G	S3B	5G	9105

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202441	5383	584	9381	2174	3W	S3A	5Q	9105
* 0201102	5236	88	9739	2474	1Z	S3B	4M	9106
* 0201110	5431	1030	9353	2474	8B	S3B	7C	9106
* 0201116	5034	548	65885	2374	7H	S3A	3W	9106
* 0201116	5034	548	65885	3372	7C		3W	9106
* 0201119	5247	594	9287	2474	7C	S3A	7C	9106
* 0201123	4946	403	65885	2374	4D	S3B	7C	9106
* 0201124	2360	959	9263	2474	1G	S3A	3Q	9106
* 0202062	5027	563	65885	2374	4D	S3B	2N	9106
* 0202062	5027	563	65885	3372	3A		2N	9106
* 0202069	5284	671	52947	2474	7C	US3A	7L	9106
* 0202092	3475	228	9629	2474	1G	S3B	5C	9106
* 0202102	4775	48	421	2174	3W	S3B	3A	9106
* 0202108	4566	662	9287	2474	7C	S3A	7D	9106
* 0202114	3925	366	421	2174	3W	S3A	7C	9106
* 0202160	4784	567	9353	2474	8P	S3B	7C	9106
* 0202166	4009	250	9539	2474	3Q	S3B	7C	9106
* 0202178	5254	1062	9381	2474	5C	S3A	4D	9106
* 0202225	6148	2630	9539	2474	7C	S3B	7K	9106
* 0202237	5241	771	9192	2474	7C	S3A	2S	9106
* 0202245	4275	49	421	2174	3W	S3B	2S	9106
* 0202268	5239	811	9739	2174	3W	S3B	3R	9106
* 0202329	5777	687	9739	2174	3W	S3B	7D	9106
* 0202350	4914	300	9353	2174	3W	S3B	3Q	9106
* 0202360	3546	0	3369	2475	3W		3R	9106
* 0202366	4648	220	9298	2174	3W	S3A	3Q	9106
* 0202380	5144	428	9298	2474	8P	S3A	1Z	9106
* 0202415	4755	435	9646	2474	6C	S3B	1Z	9106
* 0202424	4268	785	9298	2474	9C	S3A	7C	9106
* 0202428	3408	289	9381	2174	3W	S3A	3Q	9106
* 0201111	5539	271	9572	2474	7A	S3B	7C	9107
* 0201119	5247	0	9353	2474	1G	S3B	7C	9107
* 0202008	3505	51	9646	2474	3Q	S3B	1Z	9107
* 0202023	4851	94	52947	2174	3W	US3A	3P	9107
* 0202036	6666	1	52947	2474	5Q	US3A	7D	9107
* 0202047	3159	1262	65885	2374	4D	S3A	5W	9107
* 0202074	4213	655	9353	2174	3W	S3B	2N	9107
* 0202097	4043	1322	9345	2474	7C	S3A	7C	9107
* 0202103	2392	1408	65885	2374	4D	S3A		9107
* 0202106	2867	493	9287	2474	5Q	S3B	3B	9107
* 0202107	1305	32	246	2475	6K		3R	9107
* 0202129	5307	1517	9345	2474	7C	S3A	3W	9107
* 0202171	4660	478	9263	2474	7K	S3A	3A	9107
* 0202172	5388	907	9629	2474	7C	S3B	7C	9107
* 0202186	4361	4	52947	2474	5Q	US3A	7C	9107
* 0202257	6001	1034	9287	2474	7C	S3B	7C	9107
* 0202308	4269	0	68539	2475	2Q		2C	9107
* 0202377	4178	0	9353	2474	7K	S3B	3P	9107
* 0201103	5431	3	9539	2474	5Q	S3B	3D	9108
* 0201104	5327	161	9192	2474	6N	S3A	3W	9108

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0201121	2913	1423	9539	2474	5Q	S3B	4M	9108
* 0202005	5212	450	9298	2474	3Q	S3A	1Z	9108
* 0202009	5251	406	9539	2474	1G	S3B	7C	9108
* 0202009	5251	0	9287	2474	2N	S3B	1G	9108
* 0202029	5096	562	9298	2174	3W	S3A	7C	9108
* 0202041	3833	358	9192	2174	3W	S3A	3Q	9108
* 0202049	5468	272	9539	2474	5Q	S3A	6A	9108
* 0202160	4818	34	9353	2474	3T	S3B	5W	9108
* 0202188	6122	648	9192	2474	1Z	S3A	2N	9108
* 0202189	4628	1605	9345	2474	7C	S3A	7D	9108
* 0202261	5432	407	9572	2174	3W	S3B	2S	9108
* 0202264	4124	0	9226	2174	3W	S3B	3Q	9108
* 0202267	5742	0	9226	2174	4D	S3B	6P	9108
* 0202267	5753	11	9353	2474	7K	S3B	6P	9108
* 0202271	5990	199	9629	2474	5Q	S3B	5C	9108
* 0202272	4305	410	9572	2174	3W	S3B	6F	9108
* 0202274	3439	1282	65885	2374	4D	S3A	7L	9108
* 0202290	4369	155	9572	2174	3W	S3B	3R	9108
* 0202292	5730	1630	9287	2474	7C	S3B	5Q	9108
* 0202306	3921	538	9539	2174	3W	S3B	1Z	9108
* 0202306	3921	538	9539	2474	3D	S3A	1Z	9108
* 0202313	4347	0	60200	2475	7C		7C	9108
* 0202321	4445	815	9226	2474	7C	S3B	3B	9108
* 0202321	4445	0	9226	2174	4D	S3B	7C	9108
* 0202354	5027	144	9629	2174	3W	S3B	1Z	9108
* 0202363	4750	470	9646	2474	7C	S3B	7L	9108
* 0202374	3838	1018	9287	2474	5Q	S3B	3W	9108
* 0202384	4479	1067	9539	2174	3W	S3A	1Z	9108
* 0202390	5473	648	9572	2174	3W	S3B	3D	9108
* 0202395	4954	895	65885	2374	4D	S3A	7C	9108
* 0202401	4803	26	9539	2474	3P	S3B	7C	9108
* 0202403	4777	478	9226	2174	3W	S3B	3Q	9108
* 0202406	3635	830	9353	2474	1Z	S3B	5C	9108
* 0202426	5476	1008	9226	2474	3T	S3B	7C	9108
* 0201101	5295	490	9646	2474	1Z	S3B	6F	9109
* 0201118	5480	386	9381	2174	3W	S3A	3W	9109
* 0202016	5411	504	9204	2474	1Z	S3A	3R	9109
* 0202040	5012	839	9263	2174	4D	S3A	7C	9109
* 0202045	3008	79	9539	2474	5Q	S3A	3U	9109
* 0202079	6224	960	9539	2474	7C	S3B	7C	9109
* 0202087	4406	67	9539	2474	5Q	S3A	5Q	9109
* 0202093	4071	161	9381	2174	3W	S3A	7C	9109
* 0202118	5171	364	9629	2174	3W	S3B	7C	9109
* 0202147	5144	740	9298	2174	4D	S3A	5C	9109
* 0202150	6417	1041	9298	2474	7C	S3A	7C	9109
* 0202176	4607	599	9381	2174	3W	S3A	2N	9109
* 0202183	5624	1430	65885	2374	4D	S3B	5C	9109
* 0202183	5624	1430	65885	3372	1Z		5C	9109
* 0202192	5137	1900	65885	2374	4D	S3B	5C	9109
* 0202206	4390	498	52947	2474	7C	US3A	3P	9109

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202210	3592	468	9381	2174	3W	S3A	5G	9109
* 0202219	4854	785	9345	2474	3R	S3A	5G	9109
* 0202243	5235	1469	9572	2174	4D	S3B	7C	9109
* 0202247	3651	30	9226	2174	3W	S3B	6P	9109
* 0202261	5484	459	9629	2474	7C	S3B	2S	9109
* 0202263	5772	530	9263	2474	1Z	S3A	7C	9109
* 0202276	5359	881	9539	2474	7C	S3B	7C	9109
* 0202283	3725	7	9572	2474	5W	S3B	3B	9109
* 0202284	4160	399	9226	2474	2N	S3B	5C	9109
* 0202319	5303	333	9204	2474	3B	S3A	1Z	9109
* 0202341	5612	1120	9381	2174	4D	S3A	7D	9109
* 0202348	4640	85	9192	2174	3W	S3A	7K	9109
* 0202375	5367	806	9298	2474	6P	S3A	1Z	9109
* 0202388	3851	365	9192	2174	3W	S3A	2N	9109
* 0202434	3527	311	9572	2174	4D	S3B	7C	9109
* 0201022	3538	462	9353	2174	3W	S3B	3Q	9110
* 0201022	3549	473	9381	2174	3W	S3B	3Q	9110
* 0201125	5057	561	9381	2174	3W	S3B	7C	9110
* 0202004	5740	658	9192	2174	3W	S3A	7C	9110
* 0202009	5251	0	9226	2174	3W	S3B	1W	9110
* 0202010	4406	299	9646	2474	3Q	S3B	3Q	9110
* 0202035	3215	2	9739	2474	3A	S3B	3U	9110
* 0202052	4462	551	65885	2374	4D	S3A	7C	9110
* 0202068	4593	146	9539	2174	3W	S3B	7C	9110
* 0202072	4386	750	9263	2174	4D	S3A	5Q	9110
* 0202086	2287	140	9539	2174	3W	S3B	3T	9110
* 0202090	3437	0	9629	2474	2C	S3B	2A	9110
* 0202091	4211	149	9345	2174	3W	S3A	6Q	9110
* 0202098	4847	601	52947	2474	8B	US3A	7K	9110
* 0202108	4858	292	9539	2174	3W	S3B	7C	9110
* 0202111	4754	525	9204	2474	7C	S3A	7C	9110
* 0202113	4709	544	9192	2174	3W	S3A	1Z	9110
* 0202117	3939	0	9226	2174	3W	S3B	5Q	9110
* 0202125	6418	616	9204	2474	1Z	S3A	7L	9110
* 0202136	5130	397	9646	2474	7C	S3B	7C	9110
* 0202147	5165	761	9263	2474	2F	S3A	5C	9110
* 0202148	3063	1016	9263	2174	4D	S3A	7C	9110
* 0202151	4906	553	9572	2474	7A	S3B	5D	9110
* 0202156	6541	181	9572	2474	4B	S3B	7D	9110
* 0202160	4880	62	9539	2474	5Q	S3B	3T	9110
* 0202173	3300	290	9539	2474	5Q	S3B	5Q	9110
* 0202180	5657	340	9345	2174	3W	S3A	7C	9110
* 0202199	6439	186	9646	2174	3W	S3B	7C	9110
* 0202211	3881	468	9739	2474	5G	S3B	3U	9110
* 0202220	3029	0	3366	2475	3W		3M	9110
* 0202234	4121	306	9204	2474	1W	S3A	3W	9110
* 0202243	5235	1469	9539	2174	3W	S3A	7C	9110
* 0202248	4330	855	9226	2174	3W	S3B	7K	9110
* 0202280	3762	355	9287	2474	3A	S3B	7C	9110
* 0202281	5626	687	9646	2174	3W	S3B	6A	9110

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202283	3725	0	9539	2174	3W	S3A	5W	9110
* 0202299	5795	480	52947	2474	7K	US3A	6F	9110
* 0202300	4363	407	9646	2474	3D	S3B	1Z	9110
* 0202317	4173	373	9345	2474	8B	S3A	7C	9110
* 0202326	5080	677	9204	2474	7C	S3A	3A	9110
* 0202353	5210	731	9353	2174	3W	S3B	7C	9110
* 0202357	2673	0	9287	2174	3W	S3A	7C	9110
* 0202361	4347	1052	9226	2174	3W	S3B	7K	9110
* 0202369	5015	751	55600	2474	7C	S3B	3Q	9110
* 0202441	5387	588	65885	2374	4D	S3A	5Q	9110
* 0201114	4807	1100	55566	2474	3M	S3A	5C	9111
* 0202028	4177	998	9298	2174	5Q	S3A	3Q	9111
* 0202071	3941	176	9298	2174	5Q	S3A	7C	9111
* 0202076	4161	327	9298	2174	5Q	S3B	7C	9111
* 0202121	5854	338	65885	2374	4D	S3B	7C	9111
* 0202121	5854	338	65885	3372	3A		7C	9111
* 0202141	4670	113	9629	2174	3W	S3B	6F	9111
* 0202157	3418	212	9629	2474	8B	S3B	7G	9111
* 0202163	3231	216	9298	2174	3W	S3A	7C	9111
* 0202172	5388	0	9629	2475	7C		7C	9111
* 0202174	6001	4	9192	2174	3W	S3A	5C	9111
* 0202205	4938	5	9192	2174	3W	S3A	1Z	9111
* 0202208	5107	458	48556	2374	4D	S3A	3Q	9111
* 0202217	5476	194	9298	2474	3B	S3A	6K	9111
* 0202243	5277	1511	9298	2174	4D	S3B	7C	9111
* 0202262	5036	0	55600	2174	3W	S3B	6F	9111
* 0202354	5165	282	9629	2174	3W	S3B	1Z	9111
* 0202362	4323	566	55600	2174	3W	S3B	3R	9111
* 0202364	5395	52	9298	2174	5Q	S3A	7D	9111
* 0202366	4904	476	9298	2174	3W	S3A	3Q	9111
* 0202385	4196	142	48556	2374	4D	S3A	7D	9111
* 0202390	5578	753	9629	2174	3W	S3B	3D	9111
* 0202409	5098	691	9739	2474	8B	S3B	6Q	9111
* 0202420	4903	4	65885	2374	4D	S3A	6F	9111
* 0202423	4393	161	9192	2174	3W	S3A	5C	9111
* 0202424	4417	149	9345	2174	4D	S3A	7D	9111
* 0202431	4134	185	9192	2174	3W	S3A	1R	9111
* 0202432	4573	46	9539	2474	1Z	S3A	5D	9111
* 0202433	3892	1157	65885	2374	4D	S3B	5Q	9111
* 0202433	3892	1157	65885	3372	3A		5Q	9111
* 0202434	3612	396	9539	2174	3W	S3B	7C	9111
* 0202441	5387	588	65885	3372	5G		5Q	9111
* 0202020	4687	429	9204	2174	3W	S3A	7C	9112
* 0202028	4177	998	9298	2474	5Q	S3A	3Q	9112
* 0202030	4187	341	9192	2174	3W	S3A	1Z	9112
* 0202031	5880	346	9298	2474	5Q	S3A	6F	9112
* 0202036	6786	120	52947	2474	2S	US3A	5Q	9112
* 0202038	4184	618	9298	2174	3W	S3A	1Z	9112
* 0202061	6754	1419	9192	2174	3W	S3A	5G	9112
* 0202071	3942	177	9298	2174	5Q	S3A	7C	9112

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202081	5274	916	9298	2174	3W	S3A	4P	9112
* 0202156	6541	0	60200	2475	3B		5D	9112
* 0202158	5234	0	3369	2475	3W		6P	9112
* 0202186	4459	98	65885	2374	4D	US3A	5Q	9112
* 0202186	4459	98	65885	3372	3A		5Q	9112
* 0202209	4659	138	9204	2174	3W	S3A	3R	9112
* 0202215	4998	1538	9539	2474	7C	S3B	3T	9112
* 0202241	4777	510	65885	2374	4D	S3A	7C	9112
* 0202273	5078	1291	65885	2374	4D	S3A	3W	9112
* 0202323	4762	124	65885	2374	4D	US3A	8P	9112
* 0202329	5971	881	9739	2474	7C	S3B	7D	9112
* 0202340	4619	4	9739	2474	1W	S3B	4B	9112
* 0202364	5398	55	9298	2474	5Q	S3B	7D	9112
* 0201021	3893	534	9287	2474	7C	S3B	1Z	9201
* 0201104	5430	103	9298	2174	3W	S3A	6J	9201
* 0201108	5129	109	9204	2174	3W	S3A	7C	9201
* 0202004	5774	692	9381	2474	3R	S3B	7C	9201
* 0202005	5317	105	9263	2474	1W	S3A	3Q	9201
* 0202011	4048	358	9629	2474	3Q	S3B	7C	9201
* 0202025	5380	151	9298	2474	1W	S3A	3R	9201
* 0202043	5083	4	65885	2374	4D	S3A	7C	9201
* 0202056	3600	1103	9192	2174	3W	S3A	7C	9201
* 0202064	5630	508	9298	2174	3W	S3A	7A	9201
* 0202066	4376	1321	55600	2174	3W	S3B	5G	9201
* 0202070	4390	3	9539	2474	5Q	S3B	7C	9201
* 0202071	3943	178	9298	2474	1W	S3A	7C	9201
* 0202084	6179	1198	9192	2174	3W	S3A	5Q	9201
* 0202093	4202	292	9381	2174	3W	S3A	7C	9201
* 0202112	4926	1198	9192	2174	3W	S3A	3T	9201
* 0202150	6417	0	246	2475	1W		7C	9201
* 0202153	4991	326	9298	2174	3W	S3A	7C	9201
* 0202167	4022	937	9298	2474	1W	S3A	5Q	9201
* 0202174	6077	80	9192	2174	3W	S3A	5C	9201
* 0202174	6077	80	9192	2475	6A		5C	9201
* 0202190	5460	337	9298	2174	3W	S3A	7G	9201
* 0202197	5577	1116	9629	2474	3Q	S3B	7K	9201
* 0202212	5383	320	9353	2474	2N	S3B	7C	9201
* 0202214	5431	459	9204	2474	3T	S3A	7D	9201
* 0202241	4777	510	65885	3372	3A		7C	9201
* 0202253	5696	801	9345	2174	3W	S3A	3M	9201
* 0202254	5900	127	9298	2174	3W	S3A	7C	9201
* 0202259	3994	896	9298	2474	3Q	S3A	1Z	9201
* 0202262	5036	0	55600	2174	3W	S3B	6F	9201
* 0202262	5036	0	55600	2474	3P	S3B	6F	9201
* 0202273	5078	1291	65885	3372	3A		3W	9201
* 0202290	4585	371	9572	2474	3Q	S3B	3R	9201
* 0202291	4232	83	9345	2174	3W	S3A	5C	9201
* 0202294	4063	200	9298	2174	5Q	S3A	5Q	9201
* 0202297	5190	492	9298	2474	1W	S3A	7C	9201
* 0202324	4750	764	9298	2174	3W	S3B	3Q	9201

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202327	6318	222	9263	2174	3W	S3A	7D	9201
* 0202333	4442	1121	9263	2474	5Q	S3A	7C	9201
* 0202356	4973	315	65885	2374	4D	S3A	6Q	9201
* 0202366	4968	540	9298	2474	5Q	S3A	3Q	9201
* 0202368	4447	757	9298	2474	1W	S3A	5C	9201
* 0202384	4630	1218	9539	2474	2N	S3B	1Z	9201
* 0202390	5679	854	55600	2474	7C	S3B	3D	9201
* 0202398	4898	178	9298	2174	5Q	S3A	3R	9201
* 0202403	5027	728	9226	2474	3R	S3B	3Q	9201
* 0202424	4511	243	9298	2474	1W	S3A	7D	9201
* 0202444	5171	511	9572	2474	5W	S3B	1Z	9201
* 0201116	5034	0	9298	2174	3W	S3A	1Z	9202
* 0201127	4600	75	55566	2474	6F	S3A	4M	9202
* 0202002	4606	646	9192	2174	3W	S3A	6P	9202
* 0202024	4908	130	52947	2474	3P	US3A	3D	9202
* 0202029	5282	748	9298	2174	3W	S3A	7C	9202
* 0202035	3297	82	9739	2474	1W	S3B	3A	9202
* 0202048	5037	424	65885	2374	4D	S3A	1Z	9202
* 0202055	5578	191	65885	2374	4D	S3A	3T	9202
* 0202056	3600	1103	9192	2174	3W	S3A	7C	9202
* 0202056	3600	1103	9192	2174	3W	S3A	7C	9202
* 0202089	4971	529	9298	2474	3Q	S3A	7J	9202
* 0202112	4963	1235	9192	2174	3W	S3A	3T	9202
* 0202143	5175	1026	9739	2474	3P	S3B	7C	9202
* 0202163	3258	243	9298	2174	3W	S3A	7C	9202
* 0202192	5169	1932	9287	2474	2N	S3B	5C	9202
* 0202222	5931	605	9298	2174	3W	S3A	2F	9202
* 0202229	4097	226	65885	2374	4D	S3A	5Q	9202
* 0202254	5922	149	9298	2474	5Q	S3A	7C	9202
* 0202309	4760	987	55600	2474	7C	S3B	5B	9202
* 0202311	4117	365	9298	2174	3W	S3A	5C	9202
* 0202311	4117	365	9298	2174	3W	S3A	5C	9202
* 0202341	5777	1285	9263	2174	4D	S3A	7D	9202
* 0202356	4973	315	65885	3372	1Z		6Q	9202
* 0202377	4469	291	9572	2474	2S	S3B	1G	9202
* 0202388	3855	369	65885	2374	4D	S3A	2N	9202
* 0202398	4963	243	9298	2174	3W	S3A	3R	9202
* 0202409	5098	0	9739	2174	3W	S3B	8B	9202
* 0202419	2413	492	52947	2474	6N	US3A	1W	9202
* 0202430	5230	782	9739	2474	7C	S3B	4D	9202
* 0202440	5149	561	9739	2474	7A	S3B	4P	9202
* 0201119	5569	322	9287	2474	6Q	S3B	7C	9203
* 0201120	5088	47	55566	2174	3W	S3A	6Q	9203
* 0201123	4958	415	9629	2474	7C	S3B	7C	9203
* 0201124	2530	170	9298	2474	1Z	S3B	1R	9203
* 0202006	5438	1473	55566	2474	7D	S3A	5C	9203
* 0202018	4356	221	65885	2374	4D	S3A	1Z	9203
* 0202033	4448	141	55600	2174	3W	S3B	3U	9203
* 0202048	5037	424	65885	3372	1W		1Z	9203
* 0202056	3600	1103	9192	2474	3R	S3A	7C	9203

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202065	3090	436	9539	2474	8F	S3B	7C	9203
* 0202066	4399	1344	55600	2174	3W	S3B	5G	9203
* 0202067	2761	1096	9287	2474	3P	S3B	5C	9203
* 0202103	2543	1559	9192	2174	3W	S3A		9203
* 0202103	2550	1566	9287	2474	7C	S3B		9203
* 0202116	5030	517	9629	2474	7C	S3B	2N	9203
* 0202120	3405	411	9572	2474	3T	S3B	3B	9203
* 0202173	3365	65	9539	2474	3T	S3B	5Q	9203
* 0202204	5397	137	9192	2174	3W	S3A	5B	9203
* 0202228	5768	817	55566	2474	6F	S3A	3W	9203
* 0202229	4097	226	65885	3372	1W		5Q	9203
* 0202304	3551	247	9226	2474	7C	S3B	7C	9203
* 0202308	4450	181	9204	2174	4D	S3A	2Q	9203
* 0202314	3112	636	65885	2374	4D	S3A	7L	9203
* 0202317	4238	65	9298	2474	1W	S3A	3R	9203
* 0202326	5083	3	55566	2474	3T	S3A	7D	9203
* 0202331	3955	792	9539	2474	7C	S3B	3A	9203
* 0202353	5541	1062	9353	2474	3Q	S3B	7C	9203
* 0202365	6362	340	9739	2474	6N	S3B	6J	9203
* 0202401	4855	52	9539	2474	3R	S3B	3B	9203
* 0202412	4753	137	9192	2174	3W	S3A	3R	9203
* 0202413	4939	431	9539	2174	3W	S3B	7C	9203
* 0202438	5315	1316	9539	2174	3W	S3B	5C	9203
* 0201120	5131	90	55566	2174	3W	S3A	6Q	9204
* 0202007	2179	401	9646	2174	3W	S3B	7C	9204
* 0202012	5385	853	9646	2474	7C	S3B	6E	9204
* 0202023	5504	747	52947	2474	5Q	US3A	3P	9204
* 0202026	6021	483	65885	2374	4D	S3B	6P	9204
* 0202034	3771	842	9539	2174	3W	S3B	5C	9204
* 0202054	3814	465	52947	2474	3M	US3A	6F	9204
* 0202074	4217	659	65885	2374	4D	S3B	2N	9204
* 0202074	4217	659	65885	3372	6Q		2N	9204
* 0202084	6470	1489	9192	2474	7C	S3A	5Q	9204
* 0202086	2344	197	65885	2374	4D	S3A	3T	9204
* 0202096	2225	189	9539	2174	3W	S3B	3B	9204
* 0202108	4915	349	65885	2374	4D	S3A	7C	9204
* 0202117	4314	375	9226	2174	4D	S3B	5Q	9204
* 0202164	5998	981	9646	2174	3W	S3B	3A	9204
* 0202196	4275	1105	9298	2474	5W	S3B	3D	9204
* 0202268	5627	1199	9739	2474	1Z	S3B	3R	9204
* 0202281	5954	1015	9646	2474	1Z	S3B	6A	9204
* 0202343	5630	893	9345	2474	3T	S3A	3R	9204
* 0202386	4711	172	9345	2174	3W	S3A	4B	9204
* 0202394	3561	1063	9226	2474	2N	S3B	7C	9204
* 0202404	5107	43	9629	2474	2N	S3B	5B	9204
* 0202406	3650	15	55566	2474	7K	S3A	1Z	9204
* 0202416	4010	1177	9204	2174	3W	S3A	3Q	9204
* 0201116	5155	121	9298	2174	3W	S3A	1Z	9205
* 0202027	5258	846	9539	2174	3W	S3B	3T	9205
* 0202051	3989	384	9345	2474	6N	S3A	3R	9205

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202069	5422	138	52947	2474	7K	US3A	7D	9205
* 0202145	3543	407	48556	3372	4D		5C	9205
* 0202179	4100	0	3366	2475	3W		7D	9205
* 0202181	6927	930	9539	2474	8B	S3B	5Q	9205
* 0202182	6570	1336	9353	2474	3M	S3B	7C	9205
* 0202204	5482	222	9192	2174	3W	S3A	5B	9205
* 0202211	4099	218	52947	2474	1Z	US3A	7D	9205
* 0202224	5548	384	9345	2174	3W	S3A	1Z	9205
* 0202234	4206	85	52947	2474	5Q	US3A	3T	9205
* 0202235	5050	1	52947	2474	5Q	US3A	3D	9205
* 0202248	4340	865	65885	2374	4D	S3B	7K	9205
* 0202248	4340	865	65885	3372	1Z		7K	9205
* 0202272	4721	826	9263	2174	3W	S3B	6F	9205
* 0202296	5765	1275	9629	2474	8F	S3B	4P	9205
* 0202310	4649	1605	48556	3372	4D		1W	9205
* 0202321	4974	529	9539	2474	7K	S3B	7C	9205
* 0202342	3497	670	52947	2474	5Q	US3A	7K	9205
* 0202354	5488	605	9629	2474	8F	S3B	1Z	9205
* 0202361	4356	1061	65885	2374	4D	S3B	7K	9205
* 0202376	5435	188	9226	2474	8C	S3B	7D	9205
* 0202405	3549	110	9263	2174	3W	S3A	3B	9205
* 0201108	5318	298	9204	2174	4D	S3A	7C	9206
* 0202007	2311	533	9226	2474	3T	S3B	7C	9206
* 0202026	6021	483	65885	2374	4D	S3B	6P	9206
* 0202047	3302	1405	9204	2474	7D	S3A	5W	9206
* 0202052	4466	555	65885	3372	3A		7C	9206
* 0202084	6540	70	9192	2474	1B	S3A	7D	9206
* 0202085	5255	397	9204	2174	3W	S3A	3T	9206
* 0202086	2344	197	65885	3372	4D		3T	9206
* 0202093	4482	572	9381	2174	3W	S3B	7C	9206
* 0202108	4915	349	65885	3372	4D		7C	9206
* 0202113	5051	886	9381	2474	7K	S3B	1Z	9206
* 0202138	4726	1389	9287	2474	5Q	S3B	7C	9206
* 0202153	5342	677	9298	2174	3W	S3A	7C	9206
* 0202155	4777	705	65885	2374	4D	S3B	1Z	9206
* 0202169	5167	542	9381	2474	6A	S3B	1Z	9206
* 0202189	4678	50	9298	2174	3W	S3A	7C	9206
* 0202205	5163	230	9192	2474	8F	S3A	1Z	9206
* 0202210	3727	603	65885	2374	4D	S3A	5G	9206
* 0202219	4857	3	65885	2374	4D	S3A	3R	9206
* 0202256	5163	121	9298	2174	3W	S3A	7D	9206
* 0202274	3520	1363	9298	2474	7C	S3A	7L	9206
* 0202298	4227	521	63282	2474	3M	S3A	2N	9206
* 0202301	3042	1007	9739	2474	7K	S3B	7D	9206
* 0202308	4541	272	9298	2474	1Z	S3B	2Q	9206
* 0202346	4799	484	55567	2474	3Q	S3A	5W	9206
* 0202347	4196	586	9381	2474	6Q	S3B	2N	9206
* 0202355	5506	1015	9263	2174	3W	S3A	3Q	9206
* 0202357	2951	278	9287	2474	4B	S3B	7C	9206
* 0202359	5094	346	9263	2174	3W	S3A	3T	9206

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202370	5656	288	9204	2174	4D	S3A	3T	9206
* 0202370	5656	288	9298	2174	4D	S3A	3T	9206
* 0202374	3870	32	9226	2474	5Q	S3B	5Q	9206
* 0202426	5523	47	65885	2374	4D	S3B	3T	9206
* 0201113	5914	579	9287	2474	6F	S3B	3B	9207
* 0202026	6021	483	65885	3372	4D		6P	9207
* 0202029	5509	975	9298	2474	2S	S3A	7C	9207
* 0202042	5606	596	9345	2474	3R	S3A	7C	9207
* 0202078	2976	99	9298	2474	1Z	S3A	4D	9207
* 0202088	4828	912	9539	2474	3R	S3B	1G	9207
* 0202130	6138	899	9381	2474	7C	S3B	1Z	9207
* 0202141	4946	389	9629	2474	3A	S3B	6F	9207
* 0202155	4777	705	65885	3372	4D		1Z	9207
* 0202156	6631	90	9539	2474	5W	S3B	3B	9207
* 0202192	5218	49	9629	2174	3W	S3B	1W	9207
* 0202195	4615	727	9298	2474	7K	S3B	7C	9207
* 0202239	4595	228	9739	2474	9J	S3B	5W	9207
* 0202254	5992	70	9298	2174	3W	S3A	5Q	9207
* 0202269	4476	564	9298	2174	3W	S3B	5Q	9207
* 0202278	5710	225	65885	2374	4D	S3B	1W	9207
* 0202285	5388	1236	9192	2174	3W	S3A	1Z	9207
* 0202287	4405	515	9298	2174	3W	S3A	7C	9207
* 0202294	4376	513	9298	2174	3W	S3A	5Q	9207
* 0202327	6538	442	9345	2174	3W	S3A	7D	9207
* 0202334	5431	1444	0421F	2474	7C	ES3A	5C	9207
* 0202336	5380	225	65885	2374	4D	S3B	3Q	9207
* 0202351	5172	1097	9381	2474	8C	S3B	1G	9207
* 0202361	4365	1070	9353	2474	7C	S3B	7K	9207
* 0202393	5032	232	9298	2474	6J	S3A	1Z	9207
* 0202400	4463	305	0421F	2474	7C	ES3A	6P	9207
* 0202402	5474	447	9572	2474	8F	S3B	3U	9207
* 0202438	5418	1419	9539	2474	5W	S3B	5C	9207
* 0201116	5245	211	9298	2174	3W	S3A	1Z	9208
* 0201117	6400	1579	9287	2474	7C	S3B	8F	9208
* 0202001	5199	1470	9226	2474	3T	S3B	6F	9208
* 0202009	5908	657	9226	2474	7C	S3B	1W	9208
* 0202018	4359	224	65885	2374	3W	S3A	1Z	9208
* 0202022	5025	638	9572	2174	3W	S3B	3T	9208
* 0202036	7037	251	9192	2474	3T	S3A	2S	9208
* 0202045	3310	302	9539	2474	3R	S3B	7D	9208
* 0202064	5829	707	9298	2174	3W	S3A	7A	9208
* 0202132	5499	1479	9572	2174	3W	S3B	2N	9208
* 0202174	6097	20	9298	2174	3W	S3A	3T	9208
* 0202197	5766	189	65885	2374	4D	S3B	7D	9208
* 0202197	5766	189	65885	3372	3R		7D	9208
* 0202220	3141	112	9353	2174	3W	S3B	7C	9208
* 0202238	5789	1087	65885	2374	4D	S3B	6P	9208
* 0202256	5258	216	9298	2474	6J	S3A	7D	9208
* 0202265	4478	623	9539	2174	3W	S3B	7K	9208
* 0202280	3882	120	9298	2174	3W	S3A	3A	9208

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202285	5401	1249	9345	2474	3D	S3A	1Z	9208
* 0202307	5843	1157	9353	2474	3Q	S3B	7C	9208
* 0202317	4318	80	9739	2474	5C	S3B	1W	9208
* 0202336	5380	225	65885	3372	3A		3Q	9208
* 0202342	3497	0	246	2475	2A		5Q	9208
* 0202362	4576	819	55600	2474	3Q	S3B	3R	9208
* 0202363	5016	266	9287	2174	3W	S3B	7C	9208
* 0202417	6405	1599	9539	2474	7C	S3B	3A	9208
* 0202426	5523	47	65885	2374	3A	S3A	3T	9208
* 0201110	5652	221	55566	2474	3T	S3A	6Q	9209
* 0201111	5895	356	9287	2474	1B	S3B	7A	9209
* 0201127	4825	225	9381	2474	4R	S3B	6F	9209
* 0202002	4833	873	9345	2174	3W	S3A	6P	9209
* 0202064	5829	707	9298	2474	7C	S3A	7A	9209
* 0202112	5190	1462	9345	2174	3W	S3A	3T	9209
* 0202126	6081	444	9204	2174	3W	S3A	5Q	9209
* 0202127	6790	960	9381	2474	7K	S3B	1Z	9209
* 0202150	6517	0	68539	2475	3W		3T	9209
* 0202158	5489	255	9263	2174	3W	S3B	3B	9209
* 0202169	5198	31	9381	2174	3W	S3B	6A	9209
* 0202171	4974	314	9298	2474	1Z	S3A	7K	9209
* 0202203	4327	832	9381	2474	7C	S3B	5Q	9209
* 0202223	7040	414	65885	2374	3W	S3A	3R	9209
* 0202228	5868	100	9298	2474	7A	S3B	6F	9209
* 0202231	5366	515	9539	2174	3W	S3B	3R	9209
* 0202252	4323	1436	9539	2174	3W	S3B	7K	9209
* 0202263	6144	372	9204	2174	3W	S3A	1Z	9209
* 0202265	4483	628	9539	2174	3W	S3B	7K	9209
* 0202305	5087	738	9192	2474	5Q	S3A	5C	9209
* 0202306	4227	306	9539	2174	3W	S3B	7C	9209
* 0202321	5074	99	9539	2474	1Z	S3B	3T	9209
* 0202327	6609	513	9192	2474	4R	S3A	7D	9209
* 0202334	5431	0	9539	2174	3W	S3B	7D	9209
* 0202355	5522	1031	9345	2474	7K	S3A	3Q	9209
* 0202363	5024	274	9539	2474	5Q	S3B	7C	9209
* 0202370	5884	516	9381	2474	7C	S3B	3T	9209
* 0202373	4827	869	9353	2474	7C	S3B	1G	9209
* 0202398	5132	412	9298	2174	3W	S3A	3R	9209
* 0202420	5204	305	9204	2174	3W	S3A	6F	9209
* 0202428	3635	516	65885	2374	4D	S3A	3Q	9209
* 0202440	5149	0	61577	2475	3W		5C	9209
* 0202442	5080	1279	9381	2474	1G	S3B	6Q	9209
* 0201106	6116	253	9381	2174	4D	S3B	3T	9210
* 0201112	5804	615	9629	2174	3W	S3B	3M	9210
* 0201127	4826	1	9381	2174	4D	S3B	4R	9210
* 0202043	5110	31	9298	2474	4B	S3A	7C	9210
* 0202051	4118	129	55567	2474	5Q	S3A	6N	9210
* 0202083	4269	721	9345	2174	4D	S3A	2C	9210
* 0202117	4488	549	9539	2474	7C	S3B	5Q	9210
* 0202142	6080	354	65885	2374	4D	S3B	2N	9210

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202142	6080	354	65885	3372	2A		2N	9210
* 0202154	5605	858	65885	2374	3W	S3B	7C	9210
* 0202154	5606	859	65885	3372	5C		7C	9210
* 0202164	6124	1107	9539	2474	1Z	S3B	3A	9210
* 0202171	4994	20	9381	2474	8F	S3B	1Z	9210
* 0202179	4100	0	9629	2174	3W	S3B	3W	9210
* 0202218	4107	1278	9381	2174	4D	S3B	5C	9210
* 0202223	7040	414	65885	3372	3A		3R	9210
* 0202244	4705	214	9204	2174	3W	S3A	3D	9210
* 0202263	6230	458	9381	2174	4D	S3B	1Z	9210
* 0202265	4522	667	9539	2474	5Q	S3B	7K	9210
* 0202272	4826	931	9204	2474	5G	S3A	6F	9210
* 0202280	3968	206	9298	2474	6F	S3A	3A	9210
* 0202313	5103	756	9353	2474	7C	S3B	7C	9210
* 0202319	5638	335	9739	2474	5Q	S3B	5Q	9210
* 0202358	5207	310	65885	2374	3W	S3B	7C	9210
* 0202378	5079	941	9287	2474	3Q	S3B	3Q	9210
* 0202405	3679	240	9263	2474	2N	S3B	3B	9210
* 0202428	3635	516	65885	3372	6Q		3Q	9210
* 0201128	2831	898	65885	2374	4D	S3B	3Q	9210
* 0201112	5804	615	9539	2474	3Q	S3B	3M	9211
* 0202042	5606	596	9345	2174	4D	S3A	7C	9211
* 0202201	5568	925	9381	2474	5Q	S3B	5Q	9211
* 0202207	6437	1118	9263	2174	4D	S3B	1Z	9211
* 0202269	4479	567	65885	2374	3W	S3A	5Q	9211
* 0202297	5190	0	55566	2475	4L		2N	9211
* 0202379	4109	305	55566	2474	7D	S3A	7C	9211
* 0202384	4902	272	9629	2474	7K	S3B	1W	9211
* 0202410	5636	1173	9572	2474	7C	S3B	3A	9211
* 0202426	5523	47	65885	3372	3A		3T	9211
* 0202009	5908	0	60200	2475	3B		7C	9212
* 0202014	3663	1353	55566	2474	6N	ES3A	7E	9212
* 0202033	4600	293	65885	2374	3W	S3B	3U	9212
* 0202042	5606	596	9263	2474	7K	S3B	7C	9212
* 0202122	5234	284	9629	2474	8F	S3B	5Q	9212
* 0202137	5359	3	9539	2474	3P	S3B	3B	9212
* 0202213	5838	317	9539	2174	3W	S3B	3B	9212
* 0202232	6418	1007	9192	2474	5Q	S3A	3R	9212
* 0202276	5885	526	9629	2474	7C	S3B	7C	9212
* 0202290	4782	197	9539	2174	3W	S3B	3Q	9212
* 0202306	4345	424	9539	2174	3W	S3B	7C	9212
* 0202312	3803	338	9263	2174	3W	S3B	3Q	9212
* 0202331	4214	259	9539	2474	1Z	S3B	7C	9212
* 0202333	4781	339	9263	2174	3W	S3B	5Q	9212
* 0202358	5207	310	65885	3372	8P		7C	9212
* 0202394	3768	207	9539	2174	3W	S3B	1W	9212
* 0202412	5144	528	9192	2174	3W	S3A	3R	9212
* 0202443	5347	1362	65885	3372	3A		5C	9212
* 0201113	6057	143	9353	2474	1Z	S3B	6F	9301
* 0201124	2757	227	9204	2474	5G	S3B	1Z	9301

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202012	5812	427	9287	2474	6F	S3B	7D	9301
* 0202033	4600	293	65885	3372	5C		3U	9301
* 0202056	4292	692	9192	2474	7C	S3A	3R	9301
* 0202081	5641	1283	65885	3372	3R		4P	9301
* 0202085	5412	554	9204	2474	4D	S3B	3T	9301
* 0202102	5060	333	0421F	2174	4D	S3B	3A	9301
* 0202114	4210	651	0421F	2174	4D	S3B	7C	9301
* 0202114	4210	651	60200	2475	7C		7C	9301
* 0202123	5746	1255	9263	2174	3W	S3B	7H	9301
* 0202210	3859	735	9298	2174	4D	S3A	5G	9301
* 0202213	5868	347	9539	2474	1A	S3B	3B	9301
* 0202219	4990	136	9298	2174	4D	S3A	3R	9301
* 0202244	4892	401	9381	2474	4P	S3B	3D	9301
* 0202275	4196	89	65885	2374	4D	S3B	7D	9301
* 0202290	4812	227	9539	2474	5Q	S3B	3Q	9301
* 0202298	4295	68	65885	3372	3A		7D	9301
* 0202340	4860	221	9739	2474	3M	S3B	3T	9301
* 0202388	4186	700	52947	2474	7D	US3A	2N	9301
* 0202416	4113	1280	9263	2174	3W	S3B	3Q	9301
* 0201117	6415	15	55567	2474	3T	ES3A	7C	9302
* 0201127	4828	3	9345	2474	3D	S3A	4R	9302
* 0202003	5276	738	9572	2474	3R	S3B	1G	9302
* 0202007	2311	0	3367	2475	3W		3T	9302
* 0202028	4694	517	9298	2474	6Q	S3B	3T	9302
* 0202047	3512	210	9345	2474	1W	S3A	1A	9302
* 0202053	6011	249	0421F	2474	3R	ES3A	3Q	9302
* 0202068	4683	236	55567	2474	5Q	ES3A	7C	9302
* 0202086	2355	11	9226	2474	2S	S3B	5W	9302
* 0202091	4676	614	9345	2474	2C	S3A	6Q	9302
* 0202137	5361	2	0421F	2474	3P	ES3A	3P	9302
* 0202146	3575	2	61119	2475	7K		3B	9302
* 0202161	5472	957	55600	2474	3Q	S3B	1Z	9302
* 0202179	4201	101	0421F	2474	3M	S3B	3W	9302
* 0202209	5335	814	9204	2474	5G	S3B	3R	9302
* 0202211	4489	390	9381	2474	7A	S3B	1Z	9302
* 0202230	5410	1244	9204	2474	5G	S3B	3Q	9302
* 0202260	6536	918	9539	2474	1Z	S3B	7C	9302
* 0202262	5445	409	9353	2474	3M	S3B	3P	9302
* 0202283	4243	518	65885	3372	3A		5W	9302
* 0202315	4251	154	9353	2474	7C	S3B	3T	9302
* 0202397	3118	972	65885	2374	3W	S3B	3T	9302
* 0202415	4755	0	55600	2174	3W	S3B	6P	9302
* 0202421	4244	798	55567	2474	5Q	ES3A	7D	9302
* 0202434	3693	477	55567	2474	7C	ES3A	7C	9302
* 0202007	2311	0	3367	2475	3W		3W	9303
* 0202031	6464	584	9381	2474	7C	S3B	3T	9303
* 0202034	4141	1212	9353	2474	3Q	S3B	5C	9303
* 0202049	6041	573	65885	3372	3R		5Q	9303
* 0202074	4266	49	9298	2174	3W	S3A	3R	9303
* 0202101	5186	860	9539	2474	1Z	S3B	3A	9303

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202132	5510	1490	65885	3372	3R		2N	9303
* 0202137	5361	0	9539	2474	3P	S3B	3B	9303
* 0202147	5555	390	9298	2474	2F	S3A	6F	9303
* 0202158	5522	288	9204	2474	2N	S3B	3B	9303
* 0202185	5221	1242	65885	3372	3R		5D	9303
* 0202262	5446	1	9539	2474	3P	S3B	3B	9303
* 0202269	4479	567	65885	3372	6Q		5Q	9303
* 0202294	4750	887	9298	2474	6N	S3A	5Q	9303
* 0202322	5098	998	9539	2474	1Z	S3B	5Q	9303
* 0202334	5644	213	9539	2474	2N	S3B	7D	9303
* 0202339	5894	1622	9353	2474	7C	S3B	7C	9303
* 0202354	5522	34	9353	2174	3W	S3B	1W	9303
* 0202360	4101	555	65885	3372	3R		3W	9303
* 0202369	5314	299	9287	2474	3Q	S3B	7D	9303
* 0202373	4912	85	9539	2474	7C	S3B	7D	9303
* 0202424	4980	469	9204	2474	5W	S3B	2N	9303
* 0201119	5600	31	9263	2474	6F	S3B	4P	9304
* 0201124	2800	43	9345	2174	3W	S3A	5G	9304
* 0202018	4405	270	9298	2174	3W	S3A	1Z	9304
* 0202065	3212	122	9287	2474	3Q	S3B	3T	9304
* 0202131	6129	998	9629	2474	2N	S3B	7D	9304
* 0202149	5675	1080	9539	2174	3W	S3B	3W	9304
* 0202167	4492	470	9204	2474	5Q	S3B	3T	9304
* 0202181	7157	230	9572	2174	3W	S3B	6F	9304
* 0202189	5280	652	9298	2474	5Q	S3A	7C	9304
* 0202192	5860	691	9629	2174	4D	S3B	1W	9304
* 0202231	5378	527	65885	3372	3R		3R	9304
* 0202252	4334	1447	65885	3372	3R		7K	9304
* 0202257	6791	790	9572	2474	3T	S3B	7C	9304
* 0202312	4022	557	9263	2474	2N	S3B	3Q	9304
* 0202328	2746	521	9192	2474	7C	S3A	3R	9304
* 0202333	4966	524	9345	2474	8B	S3B	5Q	9304
* 0202338	4494	507	9739	2474	2C	S3B	2C	9304
* 0202395	5291	1232	9298	2474	7C	S3A	7C	9304
* 0202399	4793	863	52947	2474	7C	US3A	6N	9304
* 0202410	5639	3	9539	2474	3T	S3B	3B	9304
* 0201120	5464	423	55566	2474	3R	S3A	6Q	9305
* 0202042	5784	178	9345	2474	1T	S3B	7K	9305
* 0202047	3652	140	9298	2474	5Q	S3B	1W	9305
* 0202101	5229	43	55566	2474	3R	ES3A	3B	9305
* 0202106	3195	328	65885	2374	4D	S3B	5Q	9305
* 0202169	5822	655	9381	2174	4D	S3B	6A	9305
* 0202170	4255	1514	9204	2474	7C	S3B	7G	9305
* 0202181	7182	255	9572	2174	3W	S3B	6F	9305
* 0202192	5867	698	9539	2474	1Z	S3B	1W	9305
* 0202206	5329	939	9739	2474	7C	S3B	7D	9305
* 0202217	6422	946	9298	2474	7C	S3A	3P	9305
* 0202225	7240	1092	9263	2474	7A	S3B	7D	9305
* 0202264	5226	1102	9226	2474	7C	S3B	3Q	9305
* 0202266	3731	173	65885	2374	4D	S3B	4P	9305

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202288	4211	934	0421F	2474	3T	ES3A	5G	9305
* 0202327	6781	172	9204	2474	7K	S3B	4R	9305
* 0202335	5369	1298	9204	2174	4D	S3B	6P	9305
* 0202386	5093	554	9345	2174	3W	S3A	4B	9305
* 0202441	5938	551	9572	2174	3W	S3B	7C	9305
* 0201117	6521	106	9353	2474	4B	S3B	3B	9306
* 0202009	5997	89	9539	2474	5Q	S3B	3B	9306
* 0202011	4051	3	65885	3372	3R		3T	9306
* 0202022	5240	853	9572	2474	7C	S3B	3T	9306
* 0202046	6591	661	55566	2174	3W	S3A	7C	9306
* 0202078	3057	81	65885	2374	4D	S3A	1Z	9306
* 0202116	5367	337	55566	2474	7K	ES3A	7D	9306
* 0202163	3395	380	65885	2474	3R	S3A	7C	9306
* 0202171	5063	69	9345	2474	2N	S3A	8F	9306
* 0202198	5849	621	9345	2174	3W	S3A	6A	9306
* 0202220	3760	731	9353	2474	8F	S3B	7C	9306
* 0202226	4554	1149	9739	2474	3T	S3B	3A	9306
* 0202227	5667	200	9353	2474	6N	S3B	3Q	9306
* 0202259	4189	191	9345	2174	3W	S3B	1T	9306
* 0202342	3540	43	9192	2474	3R	S3A	5Q	9306
* 0202350	6161	1547	9353	2174	3W	S3B	3Q	9306
* 0202365	6385	23	9739	2474	1A	S3B	3A	9306
* 0202391	4207	632	9572	2474	7K	S3B	4A	9306
* 0202398	5212	492	65885	2374	4D	S3A	3R	9306
* 0202437	5398	380	9192	2474	3R	S3A	3R	9306
* 0202458	201		9345	2174	3W	S3B		9306
* 0202458	201		9345	2174	3M	S3A		9306
* 0202459	53		9298	2174	3W	S3A		9306
* 0202027	6039	1627	9539	2474	7C	S3B	3T	9307
* 0202037	4957	0	3366	2472	3W		6F	9307
* 0202053	6243	232	9629	2474	8F	S3B	3R	9307
* 0202078	3057	81	65885	3372	3R		1Z	9307
* 0202080	6783	940	9287	2474	7C	S3B	7C	9307
* 0202112	5196	1468	92685	2474	4B	S3A	3T	9307
* 0202126	6789	1152	9204	2474	3T	S3B	5Q	9307
* 0202137	5361	0	9353	2474	3P	S3B	3P	9307
* 0202202	5566	530	65885	2374	4D	S3A	7C	9307
* 0202224	5764	600	65885	3372	3R		1Z	9307
* 0202301	3196	154	9192	2474	6N	S3A	3B	9307
* 0202314	3849	1373	9353	2174	3W	S3B	7L	9307
* 0202345	5658	1413	9739	2474	3R	S3B	7C	9307
* 0202373	4975	63	9572	2474	3T	S3B	7C	9307
* 0202398	5212	492	65885	3372	3R		3R	9307
* 0202030	4972	1126	9192	2474	5Q	S3B	1Z	9308
* 0202046	6639	709	55566	2474	7C	ES3A	7C	9308
* 0202090	4509	1072	9629	2474	4B	S3B	2C	9308
* 0202208	5348	699	55566	2474	8B	ES3A	3Q	9308
* 0202284	4790	630	55566	2474	7C	S3A	2N	9308
* 0202286	2554	686	55566	2174	3W	ES3A	3D	9308
* 0202326	5406	323	9226	2474	4B	S3B	1W	9308

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202406	4216	566	9739	2474	1Z	S3B	7K	9308
* 0202436	5385	1536	9739	2474	7C	S3B	6F	9308
* 0202006	6106	668	9192	2474	6P	S3A	7D	9309
* 0202007	2562	251	9287	2474	1Z	S3B	3W	9309
* 0202083	4683	1135	9381	2474	1G	S3B	2C	9309
* 0202088	5385	557	9287	2474	7C	S3B	3R	9309
* 0202111	5749	995	9739	2474	5C	S3B	7C	9309
* 0202128	4804	429	9287	2174	3W	S3B	7C	9309
* 0202136	6111	982	9226	2474	7C	S3B	7D	9309
* 0202150	6748	231	9192	2174	3W	S3A	6N	9309
* 0202156	6631	0	3366	2472	6A		5W	9309
* 0202241	4981	204	55566	2474	5Q	S3A	8B	9309
* 0202292	6532	802	9572	2474	5W	S3B	7D	9309
* 0202306	4377	456	65885	2374	1Z	S3B	7C	9309
* 0202336	5380	0	21297	2472	3W		3R	9309
* 0202356	5409	436	9739	2174	3W	S3B	1Z	9309
* 0202394	3800	239	65885	3372	1Z		1W	9309
* 0202413	5031	523	9539	2474	1Z	S3B	7C	9309
* 0201108	5485	465	9298	2474	5Q	S3A	7C	9310
* 0201123	5661	703	9287	2474	7C	S3B	7D	9310
* 0202063	3716	580	9629	2474	7C	S3B	8C	9310
* 0202082	5091	1402	0421F	2174	4D	S3B	4D	9310
* 0202113	5051	0	3362	2472	3W		1W	9310
* 0202123	6109	1618	9298	2474	7D	S3A	7H	9310
* 0202134	5870	667	65885	2374	4D	S3B	7C	9310
* 0202139	4938	280	0421F	2174	4D	S3B	7C	9310
* 0202151	4906	0	246	2472	6A		4M	9310
* 0202218	4224	1395	55566	2474	7C	ES3A	5C	9310
* 0202239	5286	691	9345	2474	6F	S3B	9J	9310
* 0202242	6240	1456	9539	2474	1Z	S3B	7C	9310
* 0202263	6348	576	55566	2174	3W	ES3A	1Z	9310
* 0202265	4890	368	A9028	2474	5Q	ES3A	3B	9310
* 0202400	5271	808	9353	2474	6N	S3B	7D	9310
* 0202416	4476	1643	9298	2474	7D	S3A	3Q	9310
* 0202441	5946	559	65885	3372	1Z		7C	9310
* 0201115	6379	1630	9739	2474	7C	S3B	7C	9311
* 0202102	5527	800	9353	2474	8C	S3B	3A	9311
* 0202128	4955	580	9287	2474	6N	S3B	7C	9311
* 0202137	5361	0	9287	2474	3P	S3B	3B	9311
* 0202166	5124	1115	9539	2474	3B	S3B	3Q	9311
* 0202169	6178	1011	9204	2474	6N	S3B	6A	9311
* 0202177	4972	1566	9381	2474	7C	S3B	5C	9311
* 0202178	5853	599	9263	2174	3W	S3B	5C	9311
* 0202207	6793	1474	9345	2474	7C	S3A	1Z	9311
* 0202210	4294	1170	9263	2474	1A	S3B	5G	9311
* 0202219	5426	572	9263	2474	7C	S3B	3R	9311
* 0202261	6572	1088	9287	2174	3W	S3B	7D	9311
* 0202270	5747	1631	9739	2474	7C	S3B	5B	9311
* 0202304	4322	771	9629	2474	2N	S3B	7D	9311
* 0202335	5609	1538	9381	2474	7C	S3B	6P	9311

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202368	4894	447	9345	2174	3W	S3B	3T	9311
* 0202427	5240	700	9287	2474	7D	S3B	2N	9311
* 0202443	5445	98	A9028	2474	7K	ES3A	3R	9311
* 0202444	6188	1017	9226	2474	7C	S3B	5W	9311
* 0202445	383		9345	2174	3W	S3B		9311
* 0201110	5670	18	9381	2474	3T	S3B	5Q	9312
* 0201111	6136	241	65885	2374	4D	S3B	1B	9312
* 0201111	6136	241	65885	3372	3R		1B	9312
* 0201114	4781	0	21412	2472	6A		3A	9312
* 0201116	6067	1033	9298	2474	7C	S3A	1Z	9312
* 0202069	5422	0	3369	2472	2Q		7K	9312
* 0202075	4219	1354	9226	2474	6N	S3B	5C	9312
* 0202093	4613	703	65885	3372	3R		7C	9312
* 0202130	6920	782	9298	2474	7C	S3A	7C	9312
* 0202138	4765	39	9539	2174	3W	S3B	3B	9312
* 0202149	5745	1150	65885	2374	4D	S3B	3W	9312
* 0202149	5745	1150	65885	3372	3R		3W	9312
* 0202198	6062	834	9345	2174	4D	S3B	6A	9312
* 0202203	4823	496	9381	2474	3T	S3B	7C	9312
* 0202251	2661	169	5556B	2474	4P	ES3A	4B	9312
* 0202257	6796	5	55567	2174	3W	ES3A	3T	9312
* 0202259	4452	454	9345	2174	4D	S3B	1T	9312
* 0202263	6402	630	55566	2474	7C	S3A	1Z	9312
* 0202278	6307	822	9629	2474	7C	S3B	1W	9312
* 0202299	6134	339	9298	2174	3W	S3A	1T	9312
* 0202313	5650	547	55567	2174	3W	ES3A	7D	9312
* 0202333	5292	326	9345	2474	3T	S3B	7C	9312
* 0202397	3119	973	65885	2374	3W	S3B	3T	9312
* 0202397	3119	973	65885	3372	3R		3T	9312
* 0202413	5033	2	9539	2474	3B	S3B	3B	9312
* 0202419	2413	0	21412	2472	6A		2S	9312
* 0202420	5830	931	9263	2474	7C	S3B	6F	9312
* 0201110	5696	26	9345	2174	3W	S3B	3T	9401
* 0202010	4406	0	60200	2472	6A		3Q	9401
* 0202048	5509	472	9192	2174	3W	S3A	3T	9401
* 0202063	3716	0	60200	2472	3B		7C	9401
* 0202064	5834	5	65885	3372	2S		7C	9401
* 0202103	2550	0	60200	2472	6A		7A	9401
* 0202119	4607	1497	9287	2474	3P	S3B	7K	9401
* 0202138	4766	40	9226	2474	5Q	S3B	3B	9401
* 0202164	6622	498	9539	2474	4R	S3B	3B	9401
* 0202167	4898	406	9204	2474	1T	S3B	5Q	9401
* 0202168	608	0	65885	3172	3R		4D	9401
* 0202189	5280	0	3362	2472	3W		5Q	9401
* 0202199	7725	1472	9263	2474	7C	S3B	7C	9401
* 0202204	6388	1128	9192	2174	3W	S3B	5B	9401
* 0202227	5667	200	9629	2174	3W	S3B	3Q	9401
* 0202241	4981	0	61577	2472	6A		7K	9401
* 0202260	6901	365	9572	2474	3T	S3B	1Z	9401
* 0202325	5554	1056	9539	2474	8F	S3B	7D	9401

APPENDIX A. ENGINE REMOVAL DATA

SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202348	5945	1390	9192	2174	3W	S3B	7K	9401
* 0202357	3701	750	9287	2174	3W	S3B	6P	9401
* 0202368	4970	523	9345	2174	4D	S3B	3T	9401
* 0202381	3855	885	9345	2474	7C	S3B	7C	9401
* 0202388	4824	638	A9028	2474	1Z	ES3A	7D	9401
* 0202401	5842	987	9629	2174	3W	S3B	7D	9401
* 0202405	3768	89	9345	2174	3W	S3B	7D	9401
* 0202421	4301	57	9192	2174	3W	S3A	5Q	9401
* 0201120	5494	30	55566	2174	3W	S3A	1Z	9402
* 0201128	2888	955	55566	2174	3W	S3A	3Q	9402
* 0202005	5975	658	52947	2474	7C	US3A	3T	9402
* 0202068	5022	338	9287	2474	1W	S3B	5Q	9402
* 0202073	5783	1612	9572	2474	7C	S3B	7C	9402
* 0202074	4867	650	9298	2474	7C	S3A	3R	9402
* 0202117	4513	25	65885	2374	4D	S3B	7C	9402
* 0202120	4254	849	9287	2474	7D	S3B	3T	9402
* 0202238	5845	1143	55566	2174	3W	S3A	6P	9402
* 0202261	6696	1212	9287	2474	1W	S3B	7D	9402
* 0202271	7211	1221	9572	2474	7C	S3B	5Q	9402
* 0202274	3766	246	9298	2474	1G	S3A	7C	9402
* 0202286	2647	779	55566	2474	7C	S3A	3D	9402
* 0202306	4377	456	65885	3372	1Z		7C	9402
* 0202323	5750	1112	52947	2474	7C	US3A	8P	9402
* 0202353	6591	1050	9226	2474	1G	S3B	3Q	9402
* 0202358	5207	310	3362	2472	3W		7C	9402
* 0202401	5842	987	9629	2474	7C	S3B	7D	9402
* 0202407	6725	1612	9572	2474	7C	S3B	7C	9402
* 0202439	5405	853	9192	2474	6F	S3B	1Z	9402
* 0201124	2920	163	65885	3372	3R		5G	9403
* 0202009	6390	482	9629	2474	7C	S3B	3B	9403
* 0202012	6234	422	9572	2174	3W	S3B	6F	9403
* 0202015	5191	830	65885	2374	4D	S3B	1Z	9403
* 0202037	5283	326	9353	2474	5C	S3B	3W	9403
* 0202063	3751	35	9287	2474	7K	S3B	3B	9403
* 0202101	5477	248	5556B	2474	6F	ES3A	3R	9403
* 0202107	2327	1022	9381	2474	7D	S3B	6K	9403
* 0202155	4777	0	20993	2472	3W		5W	9403
* 0202181	7630	703	9572	2474	7C	S3B	6F	9403
* 0202186	5071	612	52947	2474	7C	US3A	3R	9403
* 0202260	6901	0	9572	2474	7K	S3B	3T	9403
* 0202287	5538	1648	9298	2474	7C	S3B	7C	9403
* 0202289	5497	661	A7401	2474	8F	ES3A	4B	9403
* 0202296	5788	23	65885	2374	3W	S3B	2N	9403
* 0202313	5759	656	55567	2474	7C	ES3A	7D	9403
* 0202490	0		21412	2472	3E			9403
* 0201102	6048	812	55567	2474	7C	ES3A	1Z	9404
* 0201113	6780	723	9572	2474	7C	S3B	3B	9404
* 0202055	6372	985	9298	2474	7C	S3B	3T	9404
* 0202089	4987	16	9263	2474	5D	S3A	6Q	9404
* 0202130	7004	84	9298	2474	3T	S3A	7C	9404

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202146	3573	55	52947	2474	1W	US3A	3Q	9404
* 0202172	5743	355	65885	2374	4D	S3B	7D	9404
* 0202172	5743	355	65885	3372	3R		7D	9404
* 0202278	6373	66	9287	2174	3W	S3B	7C	9404
* 0202288	4696	485	9353	2474	1W	S3B	5Q	9404
* 0202290	4889	77	9353	2174	3W	S3B	5Q	9404
* 0202311	4370	618	65885	2374	4D	S3A	5C	9404
* 0202344	5498	244	9739	2174	3W	S3B	3B	9404
* 0202359	6137	1389	9263	2474	7C	S3B	3T	9404
* 0202370	6407	523	9263	2174	3W	S3B	7C	9404
* 0202410	5750	111	65885	2374	4D	S3B	3T	9404
* 0202422	4336	647	9287	2174	3W	S3B	7D	9404
* 0202449	0		21412	2472	3W			9404
* 0201108	5020	629	9192	2474	7C	S3A	2S	9405
* 0202027	6384	345	9629	2174	3W	S3B	7C	9405
* 0202058	5164	99	65885	2374	3W	S3A	4R	9405
* 0202067	3152	391	55567	2474	7C	ES3A	3P	9405
* 0202075	4225	6	9539	2474	2N	S3B	7C	9405
* 0202088	5692	307	9287	2474	7C	S3B	7C	9405
* 0202155	4777	0	20993	2472	3W		3W	9405
* 0202173	4089	724	65885	3372	3R		3T	9405
* 0202182	6822	252	9539	2474	1Z	S3B	7C	9405
* 0202189	5436	156	55566	2174	3W	ES3A	5Q	9405
* 0202196	4778	503	9739	2174	3W	S3B	3T	9405
* 0202227	5927	460	9629	2174	3W	S3B	3Q	9405
* 0202236	7010	1198	9226	2474	3T	S3B	1B	9405
* 0202247	5124	1503	9263	2474	7C	S3B	6P	9405
* 0202248	4979	639	9381	2174	3W	S3B	1Z	9405
* 0202272	5712	883	9204	2474	3R	S3B	7D	9405
* 0202280	4499	531	9739	2474	7C	S3B	6F	9405
* 0202282	6497	1251	55567	2474	7C	ES3A	4P	9405
* 0202285	6620	1219	9381	2174	3W	S3B	3D	9405
* 0202291	5302	1153	9381	2174	4D	S3B	5C	9405
* 0202293	5399	611	9539	2474	5Q	S3B	1Z	9405
* 0202308	4724	183	9192	2474	5W	S3B	1Z	9405
* 0202335	5610	1	9263	2174	3W	S3A	7C	9405
* 0202340	5195	335	9381	2174	3W	S3B	3P	9405
* 0202377	5539	1070	9539	2474	7C	S3B	7D	9405
* 0202379	4403	294	55566	2174	3W	S3A	7D	9405
* 0202385	4840	786	55566	2474	7K	ES3A	7D	9405
* 0202409	5845	747	9739	2474	7L	S3B	8B	9405
* 0202455	878		9381	2174	3W	S3B		9405
* 0201021	3883	524	65885	2374	4D	S3A	1Z	9406
* 0201102	6068	20	9539	2474	3T	S3B	7C	9406
* 0201128	3016	1083	55566	2474	7C	S3A	3Q	9406
* 0202062	6561	1534	9353	2474	7C	S3B	7D	9406
* 0202070	5625	1235	9298	2474	7T	S3B	5Q	9406
* 0202075	4225	0	9629	2474	3R	S3B	8F	9406
* 0202098	4847	0	65885	2374	4D	S3B	5C	9406
* 0202106	3395	528	9629	2174	4D	S3B	5Q	9406

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202106	3395	528	60200	2472	3B		5Q	9406
* 0202108	5255	340	9298	2474	1W	S3A	3R	9406
* 0202119	4681	74	9287	2474	3D	S3B	3P	9406
* 0202133	4369	592	9739	2474	7C	S3B	1Z	9406
* 0202142	6285	205	9629	2174	3W	S3B	5C	9406
* 0202210	4489	195	9192	2474	5C	S3B	1A	9406
* 0202215	5508	493	5556C	2174	4D	ES3A	7D	9406
* 0202227	5927	460	9629	2474	3R	S3B	3Q	9406
* 0202267	6593	840	9629	2474	3R	S3B	3T	9406
* 0202271	7211	0	9353	2174	3W	S3B	7C	9406
* 0202276	6324	439	65885	3372	3R		7C	9406
* 0202282	6497	0	9629	2474	3R	S3B	7C	9406
* 0202291	5302	1153	9298	2474	1W	S3A	5C	9406
* 0202315	4492	241	5556C	2474	6N	ES3A	3B	9406
* 0202355	5539	17	9263	2174	4D	S3A	7C	9406
* 0202369	5323	9	65885	2374	4D	S3B	7A	9406
* 0202374	4841	971	9353	2174	3W	S3B	3B	9406
* 0202402	5671	197	5556C	2474	2S	ES3A	2N	9406
* 0202406	4430	214	9192	2474	6F	S3B	1Z	9406
* 0202442	5080	0	3360	2472	3W		1G	9406
* 0202443	5642	197	5556B	2474	7J	S3A	7K	9406
* 0202457	253		9298	2174	3W	S3A		9406
* 0202466	0		60200	2472	3B			9406
* 0201106	6419	556	9298	2474	7C	S3B	3T	9407
* 0202032	5805	1320	55567	2474	7C	ES3A	7D	9407
* 0202080	7223	440	9287	2474	7C	S3B	7C	9407
* 0202096	3318	1282	65885	2374	4D	S3B	3B	9407
* 0202150	7042	525	9192	2174	3W	S3B	6N	9407
* 0202155	4836	59	55566	2474	3B	ES3A	3W	9407
* 0202155	4386		55566	2474	3B	ES3A	3W	9407
* 0202167	4923	25	9263	2174	4D	S3B	1T	9407
* 0202220	3774	14	65885	2374	4D	S3B	8F	9407
* 0202223	7140	100	9381	2474	3T	S3B	3R	9407
* 0202255	5891	1268	9192	2174	3W	S3B	6F	9407
* 0202265	5161	271	52947	2474	5Q	US3A	7K	9407
* 0202281	6295	341	9287	2474	7C	S3B	3B	9407
* 0202284	4901	111	9739	2174	3W	S3B	7D	9407
* 0202300	5414	1051	55567	2474	7C	ES3A	3D	9407
* 0202301	3714	521	9192	2174	3W	S3B	6N	9407
* 0202329	6795	824	9192	2474	3W	S3B	7D	9407
* 0202351	6349	1177	9298	2474	1T	S3B	8C	9407
* 0202356	5772	799	9739	2474	3T	S3B	1Z	9407
* 0202412	5773	1157	9192	2174	3W	S3B	3R	9407
* 0202438	5574	156	55566	2174	3W	S3A	2N	9407
* 0202440	5871	722	55566	2174	3W	ES3A	5C	9407
* 0202447	658		9298	2174	3W	S3A		9407
* 0202451	779		9263	2174	4D	S3B		9407
* 0202454	658		9298	2174	3W	S3A		9407
* 0202075	4239	14	9287	2474	8C	S3B	3B	9408
* 0202103	2550	0	9353	2474	8B	S3B	7A	9408

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202164	6852	230	9287	2174	3W	S3B	4R	9408
* 0202206	5329	0	246	2472			7C	9408
* 0202254	6670	748	65885	2374	3W	S3B	5Q	9408
* 0202269	4479	0	246	2472	6A		3R	9408
* 0202299	6862	1067	9298	2474	7C	S3A	1T	9408
* 0202354	6593	1105	9353	2474	7C	S3B	1W	9408
* 0202391	4628	421	9298	2474	5D	S3B	7K	9408
* 0202475	445		9629	2474	2N	S3B		9408
* 0202489	15		9353	2174	3W	S3B		9408
* 0201104	6416	1089	65885	2374	3R	S3B	6J	9409
* 0201104	6416	1089	65885	3372	3R		6J	9409
* 0201114	5159	378	9572	2174	3W	S3B	3A	9409
* 0202012	6559	747	9572	2474	6J	S3B	6F	9409
* 0202086	2572	217	65885	2374	3W	S3B	2S	9409
* 0202086	2572	217	65885	3372	6Q		2S	9409
* 0202103	2550	0	9353	2474	8B	S3B	7A	9409
* 0202109	5019	1230	55567	2174	4D	ES3A	2N	9409
* 0202134	5887	684	9353	2474	7C	S3B	7C	9409
* 0202155	4386		55566	2474	3B	ES3A	3P	9409
* 0202183	7209	1585	9287	2174	4D	S3B	1Z	9409
* 0202204	6388	1128	65888	3374	2Q	S3B	5B	9409
* 0202215	5724	709	9298	2474	7C	S3B	7D	9409
* 0202238	5893	1191	55566	2474	7C	S3A	6P	9409
* 0202264	5453	227	9298	2474	3R	S3B	7C	9409
* 0202272	5904	192	5556C	2474	1Z	ES3A	3R	9409
* 0202313	6150	391	A7402	2474	7E	ES3A	7D	9409
* 0202322	5675	577	9572	2474	5W	S3B	1Z	9409
* 0202348	5945	1390	65888	3374	3R	S3B	7K	9409
* 0202355	5904	382	55566	2474	1Z	S3A	7C	9409
* 0202368	5225	778	9263	2474	7C	S3B	3T	9409
* 0202379	4584	475	55566	2474	7C	ES3A	7D	9409
* 0202386	5726	1187	9345	2474	3B	S3B	4B	9409
* 0202416	4692	216	9345	2174	3W	S3B	7C	9409
* 0202426	5523	0	246	2472	6A		3R	9409
* 0202440	5892	743	55566	2474	7C	S3A	5C	9409
* 0202003	6103	827	9353	2174	3W	S3B	3R	9410
* 0202007	3053	491	9629	2474	6J	S3B	1Z	9410
* 0202097	4905	864	65885	2374	4D	S3B	7C	9410
* 0202138	5168	402	9298	2474	6B	S3B	5Q	9410
* 0202150	7042	525	9263	2174	3W	S3B	6N	9410
* 0202151	5302	396	9345	2174	3W	S3B	4M	9410
* 0202160	5754	874	9629	2474	7C	S3B	5Q	9410
* 0202235	5780	730	9192	2174	3W	S3B	5Q	9410
* 0202241	5363	382	9298	2174	3W	US3A	6A	9410
* 0202248	5183	843	9381	2474	7K	S3B	1Z	9410
* 0202278	6554	247	9287	2174	4D	S3B	7C	9410
* 0202285	6771	1370	9263	2474	5C	S3B	3D	9410
* 0202339	6364	470	9353	2474	3P	S3B	7D	9410
* 0202375	5946	579	5556D	2174	4D	ES3A	3T	9410
* 0202378	5917	838	9298	2174	3W	S3B	3B	9410

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202403	5937	910	9298	2474	3W	S3B	3R	9410
* 0202407	6998	273	9572	2474	5Q	S3B	7D	9410
* 0202410	5765	126	9353	2174	3W	S3B	3T	9410
* 0202009	6390	482	3369	2472	6N		3B	9411
* 0202051	4688	570	65885	2374	4D	S3B	3B	9411
* 0202097	4905	864	65885	3372	3R		7C	9411
* 0202157	4566	1148	9226	2474	5Q	S3B	8B	9411
* 0202192	6033	166	9629	2474	7C	S3B	1Z	9411
* 0202198	6290	1062	9263	2174	3W	S3B	6A	9411
* 0202202	5683	647	9204	2474	7C	S3B	7C	9411
* 0202212	5881	498	65885	2374	3W	S3B	2N	9411
* 0202212	5881	498	65885	3372	3R		2N	9411
* 0202241	5365	384	5556D	2474	3T	ES3A	6A	9411
* 0202280	4499	0	9298	2474	2F	S3B	6A	9411
* 0202340	5413	553	9263	2474	7C	S3B	3P	9411
* 0202363	5610	586	A7403	2474	5C	ES3A	3B	9411
* 0202373	5046	71	65885	2374	4D	S3B	3T	9411
* 0202373	5046	71	65885	3372	3R		3T	9411
* 0202375	5946	579	9298	2474	3T	S3B	3T	9411
* 0202393	5037	237	9298	2474	3D	S3B	1Z	9411
* 0202477	939		9298	2174	3W	S3B		9411
* 0202048	5976	939	9192	2474	1Z	S3B	3T	9412
* 0202156	6739	108	A7403	2474	5W	ES3A	5W	9412
* 0202174	7244	1167	9298	2474	7C	S3B	3T	9412
* 0202185	5221	0	9192	2474	8B	S3B	3R	9412
* 0202186	5228	157	9739	2474	3T	S3B	7C	9412
* 0202206	5359	30	9298	2474	3T	S3B	6A	9412
* 0202252	4337	3	9192	2174	3W	S3B	3R	9412
* 0202290	5430	618	9298	2474	5Q	S3B	5Q	9412
* 0202328	3381	635	9192	2474	5C	S3B	7C	9412
* 0202348	5945	0	9298	2472			3R	9412
* 0202380	5910	766	9192	2474	6E	S3B	3T	9412
* 0201101	5295	0	0428A	2472	6A		6L	9501
* 0202003	6265	989	9629	2474	5Q	S3B	3R	9501
* 0202022	5880	640	9298	2474	5Q	S3B	3B	9501
* 0202027	6795	756	9629	2474	7C	S3B	7C	9501
* 0202078	3439	382	9204	2474	7C	S3B	3R	9501
* 0202082	5091	1402	0428A	2472	4D		4D	9501
* 0202108	5637	382	9298	2474	7C	S3B	3B	9501
* 0202109	5232	1443	9353	2474	6N	S3B	2N	9501
* 0202117	4513	25	65885	2374	3R	S3B	7C	9501
* 0202117	4513	25	65885	3372	3R		7C	9501
* 0202139	4938	280	0421F	2472	3W		7C	9501
* 0202143	6424	1249	9629	2474	7C	S3B	3B	9501
* 0202248	5183	843	246	2472	4R		1Z	9501
* 0202356	5801	29	9739	2474	3T	S3B	3T	9501
* 0202376	6017	582	9204	2174	3W	S3B	8C	9501
* 0202384	6239	1337	9353	2474	7C	S3B	7C	9501
* 0202393	5040	3	9204	2474	3D	S3B	3D	9501
* 0202416	4863	387	9345	2474	6J	S3B	7C	9501

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SERNO	FHSN	FHSR	REM-UIC	SSC	REASON REMOVAL	A/C	P/REASON REMOVAL	START DATE
* 0202450	1049		9204	2474	1Z	S3B		9501
* 0202456	1049		9204	2474	1Z	S3B		9501
* 0202466	252		A7403	2174	3W	ES3A		9501
* 0202490	251		A7403	2174	3W	ES3A		9501
* 0202088	6054	362	9287	2474	6F	S3B	7C	9502
* 0202096	3318	1282	65885	2374	6R	S3B	3B	9502
* 0202118	6118	1311	9353	2474	7C	S3B	7C	9502
* 0202123	6375	266	55566	2474	3T	ES3A	7D	9502
* 0202260	6901	0	65885	2374	6R	S3B	7K	9502
* 0202378	6199	1120	9298	2474	7C	S3B	3B	9502
* 0202399	5106	313	9739	2474	7C	S3B	7C	9502
* 0202427	5253	13	9353	2474	1G	S3B	7C	9502

APPENDIX B. FORMULAS AND SPREADSHEET PROCEDURES

A. WEIBULL SPREADSHEET PROCEDURES FOR CHAPTER II

1. Weibull Formulas

The spreadsheet procedures for Table 1 on page 7 of this thesis are reviewed here to provide an understanding of the computations. To calculate theta and beta with respect to a Weibull distribution, for failure time $T \sim W(\theta,\beta)$, Microsoft Excel Goal Seeking was utilized using the following equations (1) - (6):[1]

$$\frac{\Sigma T_i^{\beta}}{N} = \left[\frac{1}{N-1}\left((\Sigma T^{2\beta}) - \frac{(\Sigma T_i^{\beta})^2}{N}\right)\right]^{0.5} \qquad (1)$$

Equation (1) represents beta (hat) and is the "**Trial**" argument for goal seeking. It is solved by an iterative solution process that is done by using a spreadsheet program. The "**To Value**" is the N value represented by equation (1). The "**Changing Cell**" is the beta variable for which Goal Seeking provides a solution. Essentially, Excel solves for beta based on N in equation (1) by varying beta until it reaches the N value.

Once beta is obtained, theta is solved using equation (2) below:

$$\left(\frac{\Sigma T_i^{\beta}}{N}\right)^{1/\beta} = \hat{\theta} \qquad (2)$$

That is, the solution for beta is automatically installed in equation (2) and theta is then solved. The statistical justification for using equations (1) and (2) to solve for theta and beta is given in Caudill's thesis. [Ref. 2]

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[1] Equations 1, 2, 3, 4, 5 were developed in Reference 2 and relate to equations 24, 25, 21, 22, 16 respectively.

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This now allows MTBF and Variance to be computed using equations (3) and (4) respectively:

$$MTBF = \theta\Gamma\left(1 + \frac{1}{\beta}\right) \tag{3}$$

$$\text{Variance (T)} = \theta^2 \left[\Gamma\left(1 + \frac{2}{\beta}\right) - \Gamma^2\left(1 + \frac{1}{\beta}\right)\right] \tag{4}$$

All these formulas have been programmed into spreadsheet formulas and are solved quickly. The Gamma values that were utilized are listed on Table 8 and were inserted manually by the author. The standard deviation of T:

$$\sigma_T = \sqrt{Var(T)} = \theta \tag{5}$$

2. Non-Parametric Formulas

The formula used to obtain MTBF, equation (6), of the Non-Parametric values are a built-in statistical function in the spreadsheet. Therefore, the MTBF and the standard deviation were computed using spreadsheet functions. For example, the spreadsheet function, =AVG(*cell range*), computes the average for a defined range of values. The standard deviation was computed in the same fashion using the =STDEV(*cell range*) function.

$$MTBF = \frac{\sum_{i=1}^{N} T_i}{N} \tag{6}$$

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n	Γ (n)	n	Γ (n)	n	Γ (n)	n	Γ (n)
1.00	1.00000	1.25	.90640	1.50	.88623	1.75	.91906
1.01	.99433	1.26	.90440	1.51	.88659	1.76	.92137
1.02	.98884	1.27	.90250	1.52	.88704	1.77	.92376
1.03	.98355	1.28	.90072	1.53	.88757	1.78	.92623
1.04	.97844	1.29	.89904	1.54	.88818	1.79	.92877
1.05	.97350	1.30	.89747	1.55	.88887	1.80	.93138
1.06	.96874	1.31	.89600	1.56	.88964	1.81	.93408
1.07	.96415	1.32	.89464	1.57	.89049	1.82	.93685
1.08	.95973	1.33	.89338	1.58	.89142	1.83	.93969
1.09	.95546	1.34	.89222	1.59	.89243	1.84	.94261
1.10	.95135	1.35	.89115	1.60	.89352	1.85	.94561
1.11	.94739	1.36	.89018	1.61	.89468	1.86	.94869
1.12	.94359	1.37	.88931	1.62	.89592	1.87	.95184
1.13	.93993	1.38	.88854	1.63	.89724	1.88	.95507
1.14	.93642	1.39	.88785	1.64	.89864	1.89	.95838
1.15	.93304	1.40	.88726	1.65	.90012	1.90	.96177
1.16	.92980	1.41	.88676	1.66	.90167	1.91	.96523
1.17	.92760	1.42	.88636	1.67	.90330	1.92	.96878
1.18	.92373	1.43	.88604	1.68	.90500	1.93	.97240
1.19	.92088	1.44	.88580	1.69	.90678	1.94	.97610
1.20	.91817	1.45	.88565	1.70	.90864	1.95	.97988
1.21	.91558	1.46	.88560	1.71	.91057	1.96	.98374
1.22	.91311	1.47	.88563	1.72	.91258	1.97	.98768
1.23	.91075	1.48	.88575	1.73	.91466	1.98	.99171
1.24	.90852	1.49	.88595	1.74	.91683	1.99	.99581
						2.00	1.00000

$$\text{Values of } \Gamma(n) = \int_0^\infty \exp^{-x} x^{n-1} dx;\ \Gamma(n+1) = n\Gamma(n)$$

Table 8. GAMMA Function

APPENDIX B. FORMULAS AND SPREADSHEET PROCEDURES

B. SPREADSHEET PROCEDURES FOR A WEIBULL PDF GRAPH

These procedures apply to The Weibull PDF graph on page 11 of this thesis. Microsoft Excel has a built in Weibull function that will compute values of either the CDF or the PDF of a Weibull distribution when given the values of θ and β and the argument value x. There are four arguments to enter, =WEIBULL(x, θ, β,cumulative). The x argument denotes a value of time or a range of time values. If a PDF is desired, enter "false" in place of the cumulative argument. If a CDF is desired, enter "true" in place of the cumulative argument. This spreadsheet function can be applied to a range of failure times. The procedure described above can produce a quick graph for illustrating what failure time distribution an engine manager may be dealing with. If the θ and β values are known, they can simply be entered into the spreadsheet Weibull function. If θ and β are not known, they can be computed as described at the beginning of this appendix.

C. SPREADSHEET PROCEDURES FOR SOLVING t_0

This section depicts the spreadsheet procedures for computing t_0 using Table 7, page 43 of this thesis. The procedure is similar to the procedure for the Weibull formulas using Goal Seek tools in Microsoft Excel. The best way to compute t_0 is to leave the data entry cell for t_0 blank or enter 1. Have the cell under trial selected. This cell contains the formula, equation (10), whereby the spreadsheet will iterate until a solution is found. Select Goal Seek under the tools menu. Since the "**Trial Cell**" was previously selected, the "**To Value**" is the T_0 argument, enter 1000. The "**Changing Cell**" is t_0 cell, highlight this cell, click OK. Goal Seek will iterate several times and insert a solution into the t_0 cell.

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0201021	3359	33	9572	2474	7K	S3B	8910
* 0201022	3076	301	9646	2474	3Q	S3A	8910
* 0201022	3115	39	9646	2474	8P	S3A	9008
* 0201101	4805	685	9739	2474	4P	S3A	9002
* 0201101	5295	490	9646	2474	1Z	S3B	9109
* 0201102	5148	310	9539	2474	4M	S3B	9003
* 0201102	5236	88	9739	2474	1Z	S3B	9106
* 0201102	6068	20	9539	2474	3T	S3B	9406
* 0201103	5428	1018	9287	2474	3D	S3B	9012
* 0201103	5431	3	9539	2474	5Q	S3B	9108
* 0201104	5166	293	65885	3372	3A		9004
* 0201104	5327	161	9192	2474	6N	S3A	9108
* 0201104	6416	1089	65885	2374	3R	S3B	9409
* 0201104	6416	1089	65885	3372	3R		9409
* 0201106	5833	994	9204	2474	2N	S3A	9010
* 0201108	5485	465	9298	2474	5Q	S3A	9310
* 0201109	3606	211	9298	2474	5C	S3A	9002
* 0201110	5431	1030	9353	2474	8B	S3B	9106
* 0201110	5652	221	55566	2474	3T	S3A	9209
* 0201110	5670	18	9381	2474	3T	S3B	9312
* 0201111	5539	271	9572	2474	7A	S3B	9107
* 0201111	5895	356	9287	2474	1B	S3B	9209
* 0201111	6136	241	65885	3372	3R		9312
* 0201112	5189	927	9572	2474	3P	S3B	9007
* 0201112	5804	615	9539	2474	3Q	S3B	9211
* 0201113	5313	262	9353	2474	1Z	S3B	9006
* 0201113	5335	22	9539	2474	2N	S3B	9103
* 0201113	5914	579	9287	2474	6F	S3B	9207
* 0201113	6057	143	9353	2474	1Z	S3B	9301
* 0201114	4807	1100	55566	2474	3M	S3A	9111
* 0201116	5034	548	65885	2374	7H	S3A	9106
* 0201117	6415	15	55567	2474	3T	ES3A	9302
* 0201118	5056	67	9739	2474	6F	S3A	9001
* 0201119	5569	322	9287	2474	6Q	S3B	9203
* 0201119	5600	31	9263	2474	6F	S3B	9304
* 0201120	5041	15	9263	2474	6N	S3A	9005
* 0201120	5464	423	55566	2474	3R	S3A	9305
* 0201121	2913	1423	9539	2474	5Q	S3B	9108
* 0201124	2360	959	9263	2474	1G	S3A	9106
* 0201124	2530	170	9298	2474	1Z	S3B	9203
* 0201124	2920	163	65885	3372	3R		9403
* 0201127	4525	294	9539	2474	4M	S3B	9003

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0201127	4600	75	55566	2474	6F	S3A	9202
* 0201127	4825	225	9381	2474	4R	S3B	9209
* 0201127	4828	3	9345	2474	3D	S3A	9302
* 0202001	5199	1470	9226	2474	3T	S3B	9208
* 0202003	4538	822	9629	2474	1G	S3B	9011
* 0202003	5276	738	9572	2474	3R	S3B	9302
* 0202004	5774	692	9381	2474	3R	S3B	9201
* 0202005	4762	615	9381	2474	1Z	S3A	8912
* 0202005	5212	450	9298	2474	3Q	S3A	9108
* 0202005	5317	105	9263	2474	1W	S3A	9201
* 0202006	6106	668	9192	2474	6P	S3A	9309
* 0202007	2311	533	9226	2474	3T	S3B	9206
* 0202007	2562	251	9287	2474	1Z	S3B	9309
* 0202008	3505	51	9646	2474	3Q	S3B	9107
* 0202009	5251	406	9539	2474	1G	S3B	9108
* 0202009	5997	89	9539	2474	5Q	S3B	9306
* 0202010	4107	415	9226	2474	1G	S3B	9004
* 0202010	4406	299	9646	2474	3Q	S3B	9110
* 0202011	4048	358	9629	2474	3Q	S3B	9201
* 0202011	4051	3	65885	3372	3R		9306
* 0202012	4532	385	9263	2474	6E	S3A	9003
* 0202012	5812	427	9287	2474	6F	S3B	9301
* 0202012	6559	747	9572	2474	6J	S3B	9409
* 0202014	3663	1353	55566	2474	6N	ES3A	9212
* 0202015	4361	1327	65885	3372	3A		9104
* 0202016	5411	504	9204	2474	1Z	S3A	9109
* 0202018	4135	229	9204	2474	1Z	S3A	8912
* 0202022	4387	40	9739	2474	3T	S3A	9006
* 0202023	4757	770	9192	2474	3P	S3A	9012
* 0202023	5504	747	52947	2474	5Q	US3A	9204
* 0202024	3979	508	9204	2474	1W	S3A	9002
* 0202024	4778	67	52947	2474	3D	US3A	9105
* 0202024	4908	130	52947	2474	3P	US3A	9202
* 0202025	5229	954	9298	2474	5C	S3A	9101
* 0202025	5380	151	9298	2474	1W	S3A	9201
* 0202026	5538	516	9629	2474	1Z	S3A	8912
* 0202027	4412	1441	9192	2474	3T	S3A	9003
* 0202028	4177	998	9298	2174	5Q	S3A	9111
* 0202028	4177	998	9298	2474	5Q	S3A	9112
* 0202028	4694	517	9298	2474	6Q	S3B	9302
* 0202029	5509	975	9298	2474	2S	S3A	9207
* 0202030	3567	688	9263	2474	1Z	S3A	9005

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202030	3846	279	9381	2474	1Z	S3A	9010
* 0202030	4972	1126	9192	2474	5Q	S3B	9308
* 0202031	5534	791	9298	2474	6F	S3A	9007
* 0202031	5880	346	9298	2474	5Q	S3A	9112
* 0202033	4307	1183	9287	2474	3A	S3B	9003
* 0202033	4600	293	65885	3372	5C		9301
* 0202034	2929	155	9629	2474	5W	S3B	8910
* 0202034	4141	1212	9353	2474	3Q	S3B	9303
* 0202035	3213	595	9192	2474	3U	S3A	9102
* 0202035	3215	2	9739	2474	3A	S3B	9110
* 0202035	3297	82	9739	2474	1W	S3B	9202
* 0202036	6133	1066	9192	2474	3Q	S3A	8910
* 0202036	6666	1	52947	2474	5Q	US3A	9107
* 0202036	6786	120	52947	2474	2S	US3A	9112
* 0202036	7037	251	9192	2474	3T	S3A	9208
* 0202037	4957	2	9739	2474	6F	S3A	9002
* 0202037	5283	326	9353	2474	5C	S3B	9403
* 0202038	3566	942	9298	2474	1Z	S3A	9010
* 0202042	5606	596	9345	2474	3R	S3A	9207
* 0202042	5606	596	9263	2474	7K	S3B	9212
* 0202042	5784	178	9345	2474	1T	S3B	9305
* 0202045	2885	485	9572	2474	6J	S3B	8910
* 0202045	2929	44	9572	2474	3R	S3B	9003
* 0202045	3008	79	9539	2474	5Q	S3A	9109
* 0202045	3310	302	9539	2474	3R	S3B	9208
* 0202047	3512	210	9345	2474	1W	S3A	9302
* 0202047	3652	140	9298	2474	5Q	S3B	9305
* 0202048	5037	424	65885	3372	1W		9203
* 0202049	5186	1320	65885	3372	5Q		9002
* 0202049	5196	10	9539	2474	8P	S3A	9008
* 0202049	5468	272	9539	2474	5Q	S3A	9108
* 0202049	6041	573	65885	3372	3R		9303
* 0202051	3605	480	65885	3372	3A		9101
* 0202051	3989	384	9345	2474	6N	S3A	9205
* 0202051	4118	129	55567	2474	5Q	S3A	9210
* 0202052	4466	555	65885	3372	3A		9206
* 0202053	5762	761	9287	2474	3Q	S3B	9105
* 0202053	6011	249	0421F	2474	3R	ES3A	9302
* 0202053	6243	232	9629	2474	8F	S3B	9307
* 0202054	3314	656	9739	2474	5C	S3A	9001
* 0202054	3349	35	52947	2474	6F	US3A	9006
* 0202054	3814	465	52947	2474	3M	US3A	9204

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202055	5376	592	52947	2474	7L	US3A	9007
* 0202055	5387	11	52947	2474	1W	US3A	9009
* 0202056	3600	1103	9192	2474	3R	S3A	9203
* 0202058	5065	320	9192	2474	4R	S3A	9002
* 0202060	4917	460	52947	2474	6M	US3A	8910
* 0202060	5339	422	9192	2474	3R	S3A	9103
* 0202062	4464	40	9353	2474	1W	S3A	9002
* 0202062	5027	563	65885	3372	3A		9106
* 0202063	3016	722	421	2474	5D	S3A	8911
* 0202063	3131	115	9353	2474	7K	S3A	9008
* 0202063	3136	5	9629	2474	8C	S3B	9103
* 0202063	3751	35	9287	2474	7K	S3B	9403
* 0202064	5122	809	9204	2474	7A	S3A	8912
* 0202064	5834	5	65885	3372	2S		9401
* 0202065	3090	436	9539	2474	8F	S3B	9203
* 0202065	3212	122	9287	2474	3Q	S3B	9304
* 0202067	2761	1096	9287	2474	3P	S3B	9203
* 0202068	4683	236	55567	2474	5Q	ES3A	9302
* 0202068	5022	338	9287	2474	1W	S3B	9402
* 0202069	5422	138	52947	2474	7K	US3A	9205
* 0202070	4390	3	9539	2474	5Q	S3B	9201
* 0202070	5625	1235	9298	2474	7T	S3B	9406
* 0202071	3941	176	9298	2174	5Q	S3A	9111
* 0202071	3942	177	9298	2174	5Q	S3A	9112
* 0202071	3943	178	9298	2474	1W	S3A	9201
* 0202072	3636	1638	9192	2474	5Q	S3A	8910
* 0202074	3558	199	9646	2474	2N	S3A	9005
* 0202074	4217	659	65885	3372	6Q		9204
* 0202075	2865	1006	9298	2474	5C	S3A	9010
* 0202075	4219	1354	9226	2474	6N	S3B	9312
* 0202075	4225	6	9539	2474	2N	S3B	9405
* 0202075	4239	14	9287	2474	8C	S3B	9408
* 0202076	3715	83	9572	2474	2N	S3B	9002
* 0202076	4161	327	9298	2174	5Q	S3B	9111
* 0202078	2976	99	9298	2474	1Z	S3A	9207
* 0202078	3057	81	65885	3372	3R		9307
* 0202080	5481	3	9629	2474	3P	S3A	8911
* 0202080	5483	2	9629	2474	3P	S3A	8912
* 0202081	5641	1283	65885	3372	3R		9301
* 0202083	3548	405	9204	2474	2C	S3A	9006
* 0202083	4683	1135	9381	2474	1G	S3B	9309
* 0202084	6540	70	9192	2474	1B	S3A	9206

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202085	4858	82	9298	2474	1W	S3A	9005
* 0202086	2080	116	9629	2474	3Q	S3B	9003
* 0202086	2147	67	9539	2474	3T	S3B	9009
* 0202086	2355	11	9226	2474	2S	S3B	9302
* 0202086	2572	217	65885	3372	6Q		9409
* 0202087	4339	1285	9539	2474	5Q	S3A	9103
* 0202087	4406	67	9539	2474	5Q	S3A	9109
* 0202088	4828	912	9539	2474	3R	S3B	9207
* 0202089	4435	226	9298	2474	7A	S3A	9007
* 0202089	4442	7	9298	2474	7J	S3A	9008
* 0202089	4971	529	9298	2474	3Q	S3A	9202
* 0202089	4987	16	9263	2474	5D	S3A	9404
* 0202090	3437	376	9629	2474	1Z	S3B	9101
* 0202091	4062	168	9263	2474	1Z	S3A	9012
* 0202091	4062	168	9298	2474	5C	S3A	9103
* 0202091	4676	614	9345	2474	2C	S3A	9302
* 0202092	3475	228	9629	2474	1G	S3B	9106
* 0202093	4613	703	65885	3372	3R		9312
* 0202095	5694	89	65885	3372	1Z		9101
* 0202098	4246	333	9381	2474	7K	S3A	9008
* 0202098	4847	601	52947	2474	8B	US3A	9110
* 0202101	4326	852	65885	3372	3A		9002
* 0202101	5186	860	9539	2474	1Z	S3B	9303
* 0202101	5229	43	55566	2474	3R	ES3A	9305
* 0202101	5477	248	5556B	2474	6F	ES3A	9403
* 0202102	4727	921	65885	3372	3A		9003
* 0202102	5527	800	9353	2474	8C	S3B	9311
* 0202106	2867	493	9287	2474	5Q	S3B	9107
* 0202106	3395	528	60200	2472	3B		9406
* 0202107	1273	74	246	2475	3R		9003
* 0202107	1305	32	246	2475	6K		9107
* 0202108	5255	340	9298	2474	1W	S3A	9406
* 0202111	5749	995	9739	2474	5C	S3B	9309
* 0202113	4165	382	9263	2474	1Z	S3A	9008
* 0202113	5051	886	9381	2474	7K	S3B	9206
* 0202116	5367	337	55566	2474	7K	ES3A	9306
* 0202117	3939	1042	9226	2474	5Q	S3B	9105
* 0202119	4607	1497	9287	2474	3P	S3B	9401
* 0202119	4681	74	9287	2474	3D	S3B	9406
* 0202120	2920	660	60200	3172	5C		8912
* 0202120	2994	74	9629	2474	8P	S3B	9008
* 0202120	3405	411	9572	2474	3T	S3B	9203

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202121	5854	338	65885	3372	3A		9111
* 0202122	4950	814	9539	2474	5Q	S3B	9010
* 0202122	5234	284	9629	2474	8F	S3B	9212
* 0202125	5802	704	52947	2474	7L	US3A	8912
* 0202125	6418	616	9204	2474	1Z	S3A	9110
* 0202126	6789	1152	9204	2474	3T	S3B	9307
* 0202127	5584	291	9263	2474	1Z	S3A	8911
* 0202127	5830	246	9629	2474	1Z	S3B	9008
* 0202127	5990	160	9629	2474	3Q	S3B	9102
* 0202127	6790	960	9381	2474	7K	S3B	9209
* 0202128	4375	557	65885	3372	1Z		9103
* 0202128	4955	580	9287	2474	6N	S3B	9311
* 0202130	5239	681	9572	2474	1Z	S3B	9102
* 0202130	7004	84	9298	2474	3T	S3A	9404
* 0202131	4540	404	9226	2474	3Q	S3B	9003
* 0202131	6129	998	9629	2474	2N	S3B	9304
* 0202132	5510	1490	65885	3372	3R		9303
* 0202133	3777	560	65885	3372	1Z		9102
* 0202134	5203	1115	9226	2474	3Q	S3B	9101
* 0202137	4753	916	9739	2474	1Z	S3A	9003
* 0202137	4848	115	65885	3372	5W		9105
* 0202137	5359	3	9539	2474	3P	S3B	9212
* 0202137	5361	2	0421F	2474	3P	ES3A	9302
* 0202138	4726	1389	9287	2474	5Q	S3B	9206
* 0202138	4766	40	9226	2474	5Q	S3B	9401
* 0202139	4658	404	9539	2474	5Q	S3B	9007
* 0202140	2564	393	65885	3372	3A		9011
* 0202141	4557	242	9539	2474	6F	S3A	9105
* 0202141	4946	389	9629	2474	3A	S3B	9207
* 0202142	5726	850	9646	2474	2N	S3B	9102
* 0202142	6080	354	65885	3372	2A		9210
* 0202143	5175	1026	9739	2474	3P	S3B	9202
* 0202146	3518	892	9381	2474	5Q	S3A	9010
* 0202146	3575	2	61119	2475	7K		9302
* 0202146	3573	55	52947	2474	1W	US3A	9404
* 0202147	5165	761	9263	2474	2F	S3A	9110
* 0202147	5555	390	9298	2474	2F	S3A	9303
* 0202149	4595	485	9539	2474	3A	S3B	9003
* 0202149	5745	1150	65885	3372	3R		9312
* 0202151	4353	467	9192	2474	5D	S3A	9003
* 0202151	4906	553	9572	2474	7A	S3B	9110
* 0202154	5606	859	65885	3372	5C		9210

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202155	4072	143	9572	2474	1Z	S3B	9008
* 0202155	4836	59	55566	2474	3B	ES3A	9407
* 0202156	6631	90	9539	2474	5W	S3B	9207
* 0202157	3418	212	9629	2474	8B	S3B	9111
* 0202158	5234	202	9646	2474	3Q	S3A	8912
* 0202158	5522	288	9204	2474	2N	S3B	9303
* 0202160	4784	567	9353	2474	8P	S3B	9106
* 0202160	4818	34	9353	2474	3T	S3B	9108
* 0202160	4880	62	9539	2474	5Q	S3B	9110
* 0202161	4515	653	9287	2474	1Z	S3B	9005
* 0202161	5472	957	55600	2474	3Q	S3B	9302
* 0202163	3395	380	65885	2474	3R	S3A	9306
* 0202164	5017	337	65885	3372	3A		9004
* 0202164	6124	1107	9539	2474	1Z	S3B	9210
* 0202164	6622	498	9539	2474	4R	S3B	9401
* 0202166	4009	250	9539	2474	3Q	S3B	9106
* 0202166	5124	1115	9539	2474	3B	S3B	9311
* 0202167	4022	937	9298	2474	1W	S3A	9201
* 0202167	4492	470	9204	2474	5Q	S3B	9304
* 0202167	4898	406	9204	2474	1T	S3B	9401
* 0202169	4625	114	421	2474	1Z	S3A	9012
* 0202169	6178	1011	9204	2474	6N	S3B	9311
* 0202171	4182	362	65885	3372	3A		9002
* 0202171	4660	478	9263	2474	7K	S3A	9107
* 0202171	4974	314	9298	2474	1Z	S3A	9209
* 0202171	4994	20	9381	2474	8F	S3B	9210
* 0202171	5063	69	9345	2474	2N	S3A	9306
* 0202172	5743	355	65885	3372	3R		9404
* 0202173	3010	1030	9539	2474	5Q	S3B	9012
* 0202173	3300	290	9539	2474	5Q	S3B	9110
* 0202173	3365	65	9539	2474	3T	S3B	9203
* 0202173	4089	724	65885	3372	3R		9405
* 0202174	5997	1360	9298	2474	5C	S3A	9104
* 0202176	4008	11	9298	2474	2N	S3A	8912
* 0202178	5254	1062	9381	2474	5C	S3A	9106
* 0202179	4201	101	0421F	2474	3M	S3B	9302
* 0202181	5997	1513	9539	2474	5Q	S3B	9102
* 0202181	6927	930	9539	2474	8B	S3B	9205
* 0202182	6570	1336	9353	2474	3M	S3B	9205
* 0202182	6822	252	9539	2474	1Z	S3B	9405
* 0202183	5624	1430	65885	3372	1Z		9109
* 0202185	5221	1242	65885	3372	3R		9303

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202186	4357	381	52947	2474	2N	US3A	9005
* 0202186	4361	4	52947	2474	5Q	US3A	9107
* 0202186	4459	98	65885	3372	3A		9112
* 0202188	5474	1373	9298	2474	2N	S3A	9009
* 0202188	6122	648	9192	2474	1Z	S3A	9108
* 0202189	5280	652	9298	2474	5Q	S3A	9304
* 0202192	5169	1932	9287	2474	2N	S3B	9202
* 0202192	5867	698	9539	2474	1Z	S3B	9305
* 0202195	4615	727	9298	2474	7K	S3B	9207
* 0202196	4275	1105	9298	2474	5W	S3B	9204
* 0202197	5577	1116	9629	2474	3Q	S3B	9201
* 0202197	5766	189	65885	3372	3R		9208
* 0202201	4643	1482	9353	2474	5Q	S3B	9005
* 0202201	5568	925	9381	2474	5Q	S3B	9211
* 0202203	3448	679	9539	2474	1Z	S3B	9007
* 0202203	3495	47	9539	2474	5W	S3B	9101
* 0202203	4823	496	9381	2474	3T	S3B	9312
* 0202204	5260	804	9739	2474	5B	S3B	9012
* 0202204	6388	1128	65888	3374	2Q	S3B	9409
* 0202205	4933	914	65885	3372	1Z		9101
* 0202205	5163	230	9192	2474	8F	S3A	9206
* 0202206	3892	57	52947	2474	3P	US3A	9001
* 0202207	5319	434	9539	2474	1Z	S3B	9006
* 0202208	4624	688	9381	2474	6Q	S3A	9003
* 0202208	4649	25	9192	2474	3R	S3A	9009
* 0202208	5348	699	55566	2474	8B	ES3A	9308
* 0202209	4521	401	52947	2474	6P	US3A	9005
* 0202210	4294	1170	9263	2474	1A	S3B	9311
* 0202210	4489	195	9192	2474	5C	S3B	9406
* 0202211	3413	62	9353	2474	3U	S3A	9001
* 0202211	4099	218	52947	2474	1Z	US3A	9205
* 0202211	4489	390	9381	2474	7A	S3B	9302
* 0202212	5383	320	9353	2474	2N	S3B	9201
* 0202213	5521	1316	9353	2474	6F	S3B	9008
* 0202213	5868	347	9539	2474	1A	S3B	9301
* 0202214	5431	459	9204	2474	3T	S3A	9201
* 0202217	5282	323	9298	2474	6J	S3A	9104
* 0202217	5476	194	9298	2474	3B	S3A	9111
* 0202219	4854	785	9345	2474	3R	S3A	9109
* 0202220	2913	315	9287	2474	1Z	S3B	9001
* 0202220	3029	116	9287	2474	3M	S3B	9012
* 0202220	3760	731	9353	2474	8F	S3B	9306

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202223	6626	117	52947	2474	3R	US3A	9005
* 0202223	7040	414	65885	3372	3A		9210
* 0202223	7140	100	9381	2474	3T	S3B	9407
* 0202224	5164	902	65885	3372	1Z		9101
* 0202224	5764	600	65885	3372	3R		9307
* 0202225	7240	1092	9263	2474	7A	S3B	9305
* 0202226	3405	361	65885	3372	3A		9005
* 0202226	4554	1149	9739	2474	3T	S3B	9306
* 0202227	5467	958	9629	2474	1Z	S3B	9103
* 0202227	5667	200	9353	2474	6N	S3B	9306
* 0202227	5927	460	9629	2474	3R	S3B	9406
* 0202228	5768	817	55566	2474	6F	S3A	9203
* 0202228	5868	100	9298	2474	7A	S3B	9209
* 0202229	3871	399	9739	2474	5Q	S3A	8910
* 0202229	4097	226	65885	3372	1W		9203
* 0202231	4851	1179	65885	3372	3A		9105
* 0202231	5378	527	65885	3372	3R		9304
* 0202232	5412	1514	65885	3372	3A		9101
* 0202232	6418	1007	9192	2474	5Q	S3A	9212
* 0202233	5394	1370	9381	2474	1W	S3A	9003
* 0202233	5439	45	9298	2474	5D	S3A	9008
* 0202233	5634	195	9204	2474	8C	S3A	9105
* 0202234	3815	190	9192	2474	1Z	S3A	9012
* 0202234	4121	306	9204	2474	1W	S3A	9110
* 0202234	4206	85	52947	2474	5Q	US3A	9205
* 0202235	5045	832	52947	2474	2S	US3A	9101
* 0202235	5050	1	52947	2474	5Q	US3A	9205
* 0202236	5812	1350	9539	2474	7J	S3B	9008
* 0202236	7010	1198	9226	2474	3T	S3B	9405
* 0202237	4470	66	9298	2474	2S	S3A	8912
* 0202239	4367	896	9739	2474	5W	S3A	9012
* 0202239	4595	228	9739	2474	9J	S3B	9207
* 0202239	5286	691	9345	2474	6F	S3B	9310
* 0202241	4777	510	65885	3372	3A		9201
* 0202241	4981	204	55566	2474	5Q	S3A	9309
* 0202242	6240	1456	9539	2474	1Z	S3B	9310
* 0202244	4892	401	9381	2474	4P	S3B	9301
* 0202247	3621	879	9646	2474	3Q	S3A	9005
* 0202248	4340	865	65885	3372	1Z		9205
* 0202250	4946	733	52947	2474	5Q	US3A	9012
* 0202250	5015	69	52947	2474	5Q	US3A	9103
* 0202251	2661	169	5556B	2474	4P	ES3A	9312

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202252	4334	1447	65885	3372	3R		9304
* 0202254	5922	149	9298	2474	5Q	S3A	9202
* 0202256	5258	216	9298	2474	6J	S3A	9208
* 0202257	6791	790	9572	2474	3T	S3B	9304
* 0202259	3098	304	9298	2474	1Z	S3A	8911
* 0202259	3994	896	9298	2474	3Q	S3A	9201
* 0202260	5618	1175	9539	2474	8C	S3B	9010
* 0202260	6536	918	9539	2474	1Z	S3B	9302
* 0202260	6901	365	9572	2474	3T	S3B	9401
* 0202261	5025	436	9539	2474	2S	S3B	9007
* 0202261	6696	1212	9287	2474	1W	S3B	9402
* 0202262	5036	696	9646	2474	3Q	S3A	8911
* 0202262	5445	409	9353	2474	3M	S3B	9302
* 0202262	5446	1	9539	2474	3P	S3B	9303
* 0202263	5772	530	9263	2474	1Z	S3A	9109
* 0202264	4124	78	9646	2474	3Q	S3B	9104
* 0202264	5453	227	9298	2474	3R	S3B	9409
* 0202265	4522	667	9539	2474	5Q	S3B	9210
* 0202265	4890	368	A9028	2474	5Q	ES3A	9310
* 0202265	5161	271	52947	2474	5Q	US3A	9407
* 0202266	3218	882	421	2474	3P	S3A	9006
* 0202266	3557	339	9629	2474	1G	S3B	9104
* 0202267	5742	385	9646	2474	3Q	S3A	9001
* 0202267	5753	11	9353	2474	7K	S3B	9108
* 0202267	6593	840	9629	2474	3R	S3B	9406
* 0202268	5627	1199	9739	2474	1Z	S3B	9204
* 0202269	3912	332	9539	2474	5Q	S3B	9102
* 0202269	4479	567	65885	3372	6Q		9303
* 0202271	5791	20	9263	2474	5C	S3A	9003
* 0202271	5791	20	9263	2474	5C	S3A	9004
* 0202271	5990	199	9629	2474	5Q	S3B	9108
* 0202272	5712	883	9204	2474	3R	S3B	9405
* 0202272	5904	192	5556C	2474	1Z	ES3A	9409
* 0202273	5078	1291	65885	3372	3A		9201
* 0202274	3766	246	9298	2474	1G	S3A	9402
* 0202276	6324	439	65885	3372	3R		9406
* 0202278	5425	946	9572	2474	2N	S3B	9002
* 0202278	5470	45	9629	2474	3Q	S3B	9005
* 0202278	5485	15	9629	2474	8F	S3B	9104
* 0202280	3762	355	9287	2474	3A	S3B	9110
* 0202280	3968	206	9298	2474	6F	S3A	9210
* 0202281	4928	1555	65885	3372	3A		9002

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202281	4939	11	9629	2474	8P	S3B	9008
* 0202281	5954	1015	9646	2474	1Z	S3B	9204
* 0202282	5246	2	9646	2474	4P	S3A	8912
* 0202283	3718	570	9287	2474	2S	S3B	9102
* 0202283	3725	7	9572	2474	5W	S3B	9109
* 0202283	4243	518	65885	3372	3A		9302
* 0202284	4160	399	9226	2474	2N	S3B	9109
* 0202285	5401	1249	9345	2474	3D	S3A	9208
* 0202288	4211	934	0421F	2474	3T	ES3A	9305
* 0202288	4696	485	9353	2474	1W	S3B	9404
* 0202289	5497	661	A7401	2474	8F	ES3A	9403
* 0202290	4214	422	9539	2474	3R	S3B	9102
* 0202290	4585	371	9572	2474	3Q	S3B	9201
* 0202290	4812	227	9539	2474	5Q	S3B	9301
* 0202291	4146	816	9572	2474	3R	S3B	9005
* 0202291	5302	1153	9298	2474	1W	S3A	9406
* 0202292	6532	802	9572	2474	5W	S3B	9309
* 0202293	4634	438	9353	2474	1Z	S3A	9006
* 0202293	4788	154	9353	2474	1Z	S3B	9012
* 0202293	5399	611	9539	2474	5Q	S3B	9405
* 0202294	3863	988	9539	2474	5Q	S3B	8910
* 0202294	4063	200	9298	2174	5Q	S3A	9201
* 0202294	4750	887	9298	2474	6N	S3A	9303
* 0202296	5268	778	9287	2474	5B	S3B	9103
* 0202296	5765	1275	9629	2474	8F	S3B	9205
* 0202297	5190	492	9298	2474	1W	S3A	9201
* 0202298	4227	521	63282	2474	3M	S3A	9206
* 0202298	4295	68	65885	3372	3A		9301
* 0202299	5315	483	9739	2474	6F	S3A	9002
* 0202299	5795	480	52947	2474	7K	US3A	9110
* 0202300	3956	862	9572	2474	1Z	S3B	9101
* 0202300	4363	407	9646	2474	3D	S3B	9110
* 0202301	3042	1007	9739	2474	7K	S3B	9206
* 0202301	3196	154	9192	2474	6N	S3A	9307
* 0202302	5082	211	9381	2474	1G	S3A	9006
* 0202304	3304	290	9353	2474	1Z	S3B	9006
* 0202304	4322	771	9629	2474	2N	S3B	9311
* 0202305	4349	391	9287	2474	3Q	S3B	9010
* 0202305	5087	738	9192	2474	5Q	S3A	9209
* 0202306	3383	113	9629	2474	1Z	S3B	9001
* 0202306	3921	538	9539	2474	3D	S3A	9108
* 0202306	4377	456	65885	2374	1Z	S3B	9309

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202306	4377	456	65885	3372	1Z		9402
* 0202307	5843	1157	9353	2474	3Q	S3B	9208
* 0202308	4541	272	9298	2474	1Z	S3B	9206
* 0202308	4724	183	9192	2474	5W	S3B	9405
* 0202311	3752	27	9263	2474	5C	S3A	9004
* 0202312	3465	216	9629	2474	6Q	S3B	9103
* 0202312	4022	557	9263	2474	2N	S3B	9304
* 0202313	6150	391	A7402	2474	7E	ES3A	9409
* 0202315	4097	357	9353	2474	3T	S3B	9011
* 0202315	4492	241	5556C	2474	6N	ES3A	9406
* 0202317	4173	373	9345	2474	8B	S3A	9110
* 0202317	4238	65	9298	2474	1W	S3A	9203
* 0202317	4318	80	9739	2474	5C	S3B	9208
* 0202319	4970	268	9298	2474	1Z	S3A	9003
* 0202319	5303	333	9204	2474	3B	S3A	9109
* 0202319	5638	335	9739	2474	5Q	S3B	9210
* 0202321	4974	529	9539	2474	7K	S3B	9205
* 0202321	5074	99	9539	2474	1Z	S3B	9209
* 0202322	4100	189	9353	2474	5Q	S3B	9009
* 0202322	5098	998	9539	2474	1Z	S3B	9303
* 0202322	5675	577	9572	2474	5W	S3B	9409
* 0202323	4638	392	9353	2474	8P	S3B	9009
* 0202324	3986	860	9629	2474	5C	S3B	8911
* 0202325	5554	1056	9539	2474	8F	S3B	9401
* 0202326	4403	448	65885	3372	3A		9002
* 0202326	5083	3	55566	2474	3T	S3A	9203
* 0202327	6609	513	9192	2474	4R	S3A	9209
* 0202327	6781	172	9204	2474	7K	S3B	9305
* 0202328	2225	394	52947	2474	3R	US3A	9001
* 0202330	5157	662	9192	2474	1Z	S3A	9011
* 0202331	3163	421	65885	3372	3A		9003
* 0202331	4214	259	9539	2474	1Z	S3B	9212
* 0202333	4442	1121	9263	2474	5Q	S3A	9201
* 0202333	4966	524	9345	2474	8B	S3B	9304
* 0202333	5292	326	9345	2474	3T	S3B	9312
* 0202334	5644	213	9539	2474	2N	S3B	9303
* 0202336	4776	179	9572	2474	8F	S3B	8910
* 0202336	5155	15	9629	2474	3Q	S3B	9104
* 0202336	5380	225	65885	3372	3A		9208
* 0202338	3987	309	9381	2474	8C	S3A	9010
* 0202338	4494	507	9739	2474	2C	S3B	9304
* 0202340	4595	227	52947	2474	5W	US3A	9101

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202340	4615	20	52947	2474	2P	US3A	9103
* 0202340	4619	4	9739	2474	1W	S3B	9112
* 0202340	4860	221	9739	2474	3M	S3B	9301
* 0202342	2825	42	52947	2474	6T	US3A	9005
* 0202342	2827	2	52947	2474	7K	US3A	9101
* 0202342	3497	670	52947	2474	5Q	US3A	9205
* 0202342	3540	43	9192	2474	3R	S3A	9306
* 0202343	5630	893	9345	2474	3T	S3A	9204
* 0202345	5658	1413	9739	2474	3R	S3B	9307
* 0202346	4314	19	9353	2474	5W	S3B	9008
* 0202346	4315	1	9539	2474	5W	S3B	9101
* 0202346	4799	484	55567	2474	3Q	S3A	9206
* 0202347	3610	492	9539	2474	2N	S3A	9011
* 0202347	4196	586	9381	2474	6Q	S3B	9206
* 0202348	4555	96	9263	2474	7K	S3A	9003
* 0202348	5945	1390	65888	3374	3R	S3B	9409
* 0202351	5172	1097	9381	2474	8C	S3B	9207
* 0202351	6349	1177	9298	2474	1T	S3B	9407
* 0202353	5541	1062	9353	2474	3Q	S3B	9203
* 0202353	6591	1050	9226	2474	1G	S3B	9402
* 0202354	4883	1450	65885	3372	1Z		9011
* 0202354	5488	605	9629	2474	8F	S3B	9205
* 0202355	4491	1	9298	2474	3Q	S3A	9005
* 0202355	5522	1031	9345	2474	7K	S3A	9209
* 0202355	5904	382	55566	2474	1Z	S3A	9409
* 0202356	4456	581	9381	2474	3Q	S3A	8910
* 0202356	4658	202	9204	2474	1G	S3A	9004
* 0202356	4973	315	65885	3372	1Z		9202
* 0202356	5772	799	9739	2474	3T	S3B	9407
* 0202358	5207	310	65885	3372	8P		9212
* 0202359	4736	355	52947	2474	8C	US3A	9009
* 0202359	4748	12	52947	2474	3T	US3A	9101
* 0202360	3352	193	9353	2474	1G	S3A	9001
* 0202360	3546	387	9572	2474	3P	S3B	9006
* 0202360	4101	555	65885	3372	3R		9303
* 0202361	3295	484	9353	2474	1W	S3A	9001
* 0202362	4576	819	55600	2474	3Q	S3B	9208
* 0202363	4001	888	9226	2474	1Z	S3B	9004
* 0202363	4280	279	9646	2474	7K	S3B	9012
* 0202363	5024	274	9539	2474	5Q	S3B	9209
* 0202364	5343	1084	9298	2474	6J	S3A	9104
* 0202364	5395	52	9298	2174	5Q	S3A	9111

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202364	5398	55	9298	2474	5Q	S3B	9112
* 0202365	6022	745	9298	2474	6J	S3A	9104
* 0202365	6362	340	9739	2474	6N	S3B	9203
* 0202365	6385	23	9739	2474	1A	S3B	9306
* 0202366	4428	56	9298	2474	2C	S3A	9007
* 0202366	4968	540	9298	2474	5Q	S3A	9201
* 0202367	4118	46	52947	2474	8C	US3A	9005
* 0202367	4201	83	52947	2474	1G	US3A	9104
* 0202368	3690	176	9192	2474	5C	S3A	8910
* 0202368	4447	757	9298	2474	1W	S3A	9201
* 0202369	5314	299	9287	2474	3Q	S3B	9303
* 0202370	4750	263	9739	2474	6F	S3A	8911
* 0202370	5368	618	52947	2474	3T	US3A	9012
* 0202373	3958	333	9226	2474	1G	S3B	9003
* 0202373	4975	63	9572	2474	3T	S3B	9307
* 0202374	3838	1018	9287	2474	5Q	S3B	9108
* 0202374	3870	32	9226	2474	5Q	S3B	9206
* 0202375	5367	806	9298	2474	6P	S3A	9109
* 0202376	5435	188	9226	2474	8C	S3B	9205
* 0202377	3701	609	9226	2474	3Q	S3B	9001
* 0202377	4178	477	9539	2474	3P	S3B	9104
* 0202377	4469	291	9572	2474	2S	S3B	9202
* 0202378	4138	230	9298	2474	3Q	S3A	9006
* 0202378	5079	941	9287	2474	3Q	S3B	9210
* 0202379	3804	1617	9539	2474	1C	S3B	9006
* 0202380	4716	953	9263	2474	1Z	S3A	9005
* 0202380	5144	428	9298	2474	8P	S3A	9106
* 0202383	4488	704	52947	2474	1Z	US3A	9003
* 0202383	4497	9	52947	2474	6F	US3A	9104
* 0202384	4630	1218	9539	2474	2N	S3B	9201
* 0202384	4902	272	9629	2474	7K	S3B	9211
* 0202385	4840	786	55566	2474	7K	ES3A	9405
* 0202386	4520	126	9204	2474	1Z	S3A	8910
* 0202386	4539	19	9263	2474	2A	S3A	9006
* 0202386	5726	1187	9345	2474	3B	S3B	9409
* 0202388	4824	638	A9028	2474	1Z	ES3A	9401
* 0202390	4825	347	9646	2474	7A	S3A	9002
* 0202391	3575	417	9263	2474	4P	S3A	9105
* 0202391	4207	632	9572	2474	7K	S3B	9306
* 0202391	4628	421	9298	2474	5D	S3B	9408
* 0202392	2619	55	246	2475	3R		9003
* 0202393	4800	667	52947	2474	1Z	US3A	8911

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202393	5032	232	9298	2474	6J	S3A	9207
* 0202394	3561	1063	9226	2474	2N	S3B	9204
* 0202394	3800	239	65885	3372	1Z		9309
* 0202397	2146	215	9226	2474	3T	S3B	9008
* 0202397	3119	973	65885	3372	3R		9312
* 0202398	4720	1598	9298	2474	3R	S3A	9102
* 0202398	4898	178	9298	2174	5Q	S3A	9201
* 0202398	5212	492	65885	3372	3R		9307
* 0202399	3930	291	52947	2474	6N	US3A	9003
* 0202400	5271	808	9353	2474	6N	S3B	9310
* 0202401	4167	305	65885	3372	3A		8911
* 0202401	4803	26	9539	2474	3P	S3B	9108
* 0202401	4855	52	9539	2474	3R	S3B	9203
* 0202402	5027	2128	9353	2474	1Z	S3A	9003
* 0202402	5474	447	9572	2474	8F	S3B	9207
* 0202402	5671	197	5556C	2474	2S	ES3A	9406
* 0202403	4299	1165	9539	2474	3T	S3B	8911
* 0202403	5027	728	9226	2474	3R	S3B	9201
* 0202404	5064	509	9629	2474	5B	S3B	9102
* 0202404	5107	43	9629	2474	2N	S3B	9204
* 0202405	3679	240	9263	2474	2N	S3B	9210
* 0202406	3635	830	9353	2474	1Z	S3B	9108
* 0202406	3650	15	55566	2474	7K	S3A	9204
* 0202406	4216	566	9739	2474	1Z	S3B	9308
* 0202406	4430	214	9192	2474	6F	S3B	9406
* 0202409	5098	691	9739	2474	8B	S3B	9111
* 0202409	5845	747	9739	2474	7L	S3B	9405
* 0202410	4463	1176	65885	3372	3A		9003
* 0202410	5639	3	9539	2474	3T	S3B	9304
* 0202412	4616	1613	65885	3372	3A		9102
* 0202413	5031	523	9539	2474	1Z	S3B	9309
* 0202413	5033	2	9539	2474	3B	S3B	9312
* 0202415	4755	435	9646	2474	6C	S3B	9106
* 0202417	4806	1164	65885	3372	3A		8911
* 0202419	1873	686	9739	2474	1W	S3A	8910
* 0202419	1921	48	52947	2474	1W	US3A	9001
* 0202419	2413	492	52947	2474	6N	US3A	9202
* 0202420	4405	226	9572	2474	7K	S3B	8910
* 0202420	4899	494	9353	2474	6F	S3B	9104
* 0202421	4244	798	55567	2474	5Q	ES3A	9302
* 0202423	4232	1399	9539	2474	5C	S3B	9011
* 0202424	4268	785	9298	2474	9C	S3A	9106

APPENDIX C. FAILURE TIME BETWEEN REPAIRS

SERNO	FHSN	FHSR	REM-UIC	SSC	REA-REM	A/C	START DATE
* 0202424	4511	243	9298	2474	1W	S3A	9201
* 0202424	4980	469	9204	2474	5W	S3B	9303
* 0202426	5476	1008	9226	2474	3T	S3B	9108
* 0202426	5523	47	65885	2374	3A	S3A	9208
* 0202426	5523	47	65885	3372	3A		9211
* 0202427	4540	345	9646	2474	2N	S3B	9102
* 0202428	3119	162	9629	2474	3Q	S3B	9004
* 0202428	3635	516	65885	3372	6Q		9210
* 0202431	3949	441	9739	2474	1G	S3B	9105
* 0202432	4527	1379	9226	2474	3Q	S3B	9104
* 0202432	4573	46	9539	2474	1Z	S3A	9111
* 0202433	3892	1157	65885	3372	3A		9111
* 0202437	4948	313	52947	2474	6F	US3A	9008
* 0202437	5018	70	52947	2474	3R	US3A	9102
* 0202437	5398	380	9192	2474	3R	S3A	9306
* 0202438	5418	1419	9539	2474	5W	S3B	9207
* 0202439	4403	811	9298	2474	3Q	S3A	9001
* 0202439	4552	149	65885	3372	1Z		9012
* 0202439	5405	853	9192	2474	6F	S3B	9402
* 0202440	4588	116	9204	2474	4P	S3A	9003
* 0202440	5149	561	9739	2474	7A	S3B	9202
* 0202441	5946	559	65885	3372	1Z		9310
* 0202442	5080	1279	9381	2474	1G	S3B	9209
* 0202443	5347	1362	65885	3372	3A		9212
* 0202443	5445	98	A9028	2474	7K	ES3A	9311
* 0202443	5642	197	5556B	2474	7J	S3A	9406
* 0202444	4656	37	9353	2474	1Z	S3B	9009
* 0202444	4660	4	9646	2474	1Z	S3B	9101
* 0202444	5171	511	9572	2474	5W	S3B	9201

APPENDIX D. FORMULAS FOR COMPUTING NO-BUILD TIMES

A. OPTIMUM TIME EQUATION FOR SETTING t_0

Notation used in this appendix is given on page 40 of this thesis. If IR is performed on the SI component at the time of engine failure, with t_0 operating hours on the component, the IR cost per unit time is C_N/t_0. If the decision is made to wait for the next engine failure and the SI component survives that remaining time the average IR cost per unit time is approximately

$$C_N \int_0^{T_0 - t_0} \frac{1}{t_0 + t} f_e(t) \bar{F}(t + t_0 \setminus t_0) dt \cong \left[C_N \int_0^{T_0 - t_0} \frac{1}{t_0 + t} f_e(t) dt \right] \bar{F}(T_0 \setminus t_0). \qquad (13)$$

The approximation indicated in equation (13) will be very good if the residual reliability $\bar{F}(T_0 \setminus t_0)$ is close to one, which will probably be the case because the high time T_0 is set so that $\bar{F}(T_0)$ is close to one and $\bar{F}(T_0 \setminus t_0) > \bar{F}(T_0)$. See equation (17).

If IR is not performed on the SI component at the time of engine failure, t_e, and if there is no engine failure in the first $T_0 - t_0$ time units after it is returned to service, the average IR cost per unit time for the SI component is,

$$\frac{C_I}{T_0} \bar{F}_e(T_0 - t_0) \bar{F}(T_0 \setminus t_0). \qquad (14)$$

If the decision is made not to repair the SI component at the time of engine failure, and the SI component fails between operating time t_0 and T_0 and if C_F is the cost of repairing this component when it fails, then the cost per unit time is determined using the equation

$$C_F \int_{t_0}^{T_0} \frac{1}{t} f(t \setminus t_0) dt \cong \frac{C_F}{T_0} F(T_0 \setminus t_0), \qquad (15)$$

where $f(t \setminus t_0)$ is the conditional density function of the time to failure of the SI component given it is still operating at time t_0.

The expression

$$\frac{C_F}{T_0} F(T_0 \setminus t_0) \tag{16}$$

will likely be quite small because $F(T_0 \setminus t_0)$ is smaller than $F(T_0)$ which is itself very small because the HT time, T_0, is chosen to make an SI failure highly unlikely before time T_0. That is,

$$F(T_0 \setminus t_0) = P(T < T_0 \setminus T > t_0) = \frac{P(t_0 < T < T_0)}{P(t > t_0)} = \frac{P(T > t_0) - P(T > T_0)}{P(t > t_0)}$$
$$= 1 - \frac{P(T > T_0)}{P(T > t_0)} < 1 - P(T > T_0) = F(T_0). \tag{17}$$

In equation (16), if $T_0 = 1000$ hours and $F(T_0 \setminus t_0) = 0.01$, then

$$\frac{C_F}{T_0} F(T \setminus t_0) = C_F(0.00001). \tag{18}$$

If $C_F = \$1{,}000{,}000$, this average cost per unit time expression would be \$10/hour.

The total equation to solve for the optimum time t_0 is given in equation (19).

$$\frac{C_N}{t_0} = C_N \int_0^{T_0 - t_0} \frac{1}{t + t_0} f_e(t) \bar{F}(t + t_0 \setminus t_0) dt + \frac{C_I}{T_0} \bar{F}_e(T_0 - t_0) \bar{F}(T_0 - t_0)$$
$$+ C_F \int_{t_0}^{T_0} \frac{1}{t} f(t \setminus t_0) dt \tag{19}$$

APPENDIX D. FORMULAS FOR COMPUTING NO-BUILD TIMES

Dropping the last term in equation (19) (because it is small) and using the approximation given in equation (13), yields the equation

$$\frac{C_N}{t_0} = \left[C_N \int_0^{T_0 - t_0} \frac{1}{t + t_0} f_e(t)dt + \frac{C_I}{T_0} \bar{F}_e(T_0 - t_0) \right] \bar{F}(T_0 \setminus t_0). \qquad (20)$$

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